STATE BOARD OF HEALTH

MAP OF THE

STATE OF MASSACHUSETTS.

SHOWING

RIVER BASINS,

AND PLACES AT WHICH

SAMPLES OF WATER WERE COLLECTED.

SCALE OF

0 2 4 6 8 10 12 14

HELIOTYPE PRINTING CO.

MPSHIRE
RHODE ISLAND
ATLANTIC OCEAN
CAPE COD BAY
BUZZARDS BAY
VINEYARD SOUND
NASHUA
MERRIMACK RIVER
CONCORD
IPSWICH
MYSTIC
CHARLES
NEPONSET
BLACKSTONE
TAUNTON
STONY BROOK
NEWBURY
GEORGETOWN
ROWLEY
GLOUCESTER
ROCKPORT
MANCHESTER
BEVERLY
DANVERS
TOWNSEND
PEPPERELL
DUNSTABLE
CHELMSFORD
BOLTON
STOW
BERLIN
HUDSON
SUDBURY
MARLBOROUGH
SOUTHBOROUGH
ASHLAND
NEWTON
WELLESLEY
NEEDHAM
SHERBORN
HOLLISTON
MEDWAY
MILLBURY
GRAFTON
SUTTON
UPTON
DOUGLAS
UXBRIDGE
MENDON
QUINCY
BRAINTREE
HINGHAM
SCITUATE
NORWELL
HANOVER
MARSHFIELD
PEMBROKE
DUXBURY
KINGSTON
PLYMOUTH
BROCKTON
WHITMAN
FOXBOROUGH
MANSFIELD
NORTON
MIDDLEBOROUGH
SEEKONK
REHOBOTH
SWANSEA
DIGHTON
BERKELEY
FREETOWN
ROCHESTER
WAREHAM
MARION
MATTAPOISETT
NEW BEDFORD
FAIR HAVEN
DARTMOUTH
WESTPORT
SANDWICH
FALMOUTH
MASHPEE
BARNSTABLE
YARMOUTH
DENNIS
BREWSTER
HARWICH
CHATHAM
WELLFLEET
TRURO
PROVINCETOWN
NAUSHON
CHILMARK
TISBURY
EDGARTOWN
GAY HEAD
NANTUCKET
SCALE OF MILES.
4 6 8 10 12 14 16 18 20 22 24 26 28 30

EXAMINATIONS

BY THE

STATE BOARD OF HEALTH

OF THE

WATER SUPPLIES AND INLAND WATERS

OF MASSACHUSETTS.

1887–1890.

PART I.

OF

REPORT ON WATER SUPPLY AND SEWERAGE.

BOSTON:
WRIGHT & POTTER PRINTING CO., STATE PRINTERS,
18 POST OFFICE SQUARE.
1890.

Part I.

CONTENTS.

INTRODUCTION.

The two volumes upon water supply and sewerage, which are now published under the direction of the State Board of Health, are issued under the provisions of chapter 80 of the Resolves of the General Court of 1889.

By the "Act to protect the Purity of Inland Waters," which had been outlined and recommended by the Massachusetts Drainage Commission of 1884, the State Board of Health, soon after its reorganization in 1886, was entrusted with the important duty of carrying out the provisions of the act. This act, as amended in 1888, is given in full on page xvii.

The value of this broad and far-reaching statute has already been demonstrated by its application to many of the municipalities of the State, as reported upon in the annual reports of the Board.

The State Board of Health is also required, by the terms of the same act, "from time to time, as it may deem expedient, to cause examinations of the waters to be made, for the purpose of ascertaining whether the same are adapted for use as sources of domestic water supplies, or are in a condition likely to impair the interests of the public or persons lawfully using the same, or imperil the public health."

The Board is also authorized "to conduct experiments to determine the best practicable methods of purification of drainage and sewage, or disposal of the same."

The work of the Board in performing these two distinct duties — the examination of water supplies and the conducting of experiments upon sewage disposal — forms the subject of these volumes.

The general subject of the FIRST VOLUME is the examination of the water supplies of the State, and embraces not only an examination of the water supplies already in use, but also of the rivers, and of many available sources of supply not now in use. The rapid increase of

public water supplies in Massachusetts in the past twenty years has made imperative the legislation which was provided for by the act already referred to. Previous to the enactment of this statute, no comprehensive plan of work had been carried out. The topography of the Commonwealth is peculiarly fitted for this comprehensive study, embracing, as it does, waters of varying character, from the more highly colored waters of the marshes and bogs of the low lands, to the clearer waters of the Berkshire hills, including the polluted waters of thickly settled regions and the unpolluted waters of uninhabited regions.

These waters have been made the object of thorough study by the engineer, the chemist, the biologist, and by members of the Board. A large portion of these pages covers a period of two years; and in some of the discussions the results of the third and a portion of the fourth year's work have been used. The analyses made in these years will be published in the twenty-second annual report of the Board.

The final conclusions in regard to some of these supplies must be reserved until a season of drought shall have shown what changes are possible under conditions widely different from those which have existed during the past four years.

In the first part of this volume are presented the descriptions of the water works of the State, embracing one hundred and thirty-five supplies furnished to cities and towns and to a portion of the public institutions of the State. The number of cities and towns to which water is furnished is greater, since, in several instances, two or more municipalities are supplied by one system of works. An alphabetical arrangement has been adopted for this portion of the volume, as the most convenient for the sake of reference, so that any system of water works may be found under the name of the city or town to which the water is furnished. Analyses of the water of several sources which have not been used as water supplies are also presented, as, for example, several of the large ponds in Barnstable and Plymouth counties.

The following table comprises all the cities, towns and public institutions embraced in the list:—

Cities and Towns.	Population. Census of 1890.	Cities and Towns.	Population. Census of 1890.	Cities and Towns.	Population. Census of 1890.
Abington,	4,260	Haverhill,	27,412	Orange,	4,568
Adams (South Adams Fire District),	9,213	Hingham,	4,564	Palmer,	6,520
Agawam,	2,352	Hinsdale,	1,739	Peabody,	10,158
Amesbury,	9,798	Holbrook,	2,474	Phillipston,	502
Amherst,	4,512	Holyoke,	35,637	Pittsfield,	17,281
Arlington (and Middlesex Aqueduct Company).	5,629	Hopedale,	1,176	Plymouth,	7,314
Ashburnham,	2,074	Hopkinton,	4,088	Provincetown,	4,642
Athol,	6,319	Hudson,	4,670	Quincy,	16,723
Attleborough,	7,577	Hull,	989	Randolph,	3,946
Avon,	1,384	Hyde Park,	10,193	Revere,	5,668
Ayer,	2,148	Kingston,	1,659	Richmond,	796
Barnstable (Nine-Mile Pond),	4,023	Lakeville,	935	Rockland,	5,213
Belmont,	2,098	Lancaster,	2,201	Salem,	30,801
Beverly,	10,821	Lawrence,	44,654	Saugus,	3,673
Boston,	448,477	Lee,	3,785	Sharon,	1,634
Braintree,	4,848	Leicester,	3,120	Shelburne,	1,553
Brewster (Long Pond),	1,003	Lenox,	2,889	Sherborn (Reformatory Prison),	–
Bridgewater (and State Farm).	4,249	Leominster,	7,269	Somerville,	40,152
Brockton,	27,294	Lexington,	3,197	Southbridge,	7,655
Brookfield,	3,352	Lincoln,	987	South Hadley,	4,261
Brookline,	12,103	Lowell,	77,696	Spencer,	8,747
Cambridge,	70,028	Ludlow,	1,939	Springfield,	44,179
Canton,	4,538	Lynn,	55,727	Stockbridge,	2,132
Chelsea,	27,909	Lynnfield,	787	Stoneham,	6,155
Cheshire,	1,308	Malden,	23,031	Stoughton,	4,852
Chicopee (and Chicopee Falls).	14,050	Mansfield,	3,432	Swampscott,	3,198
Clinton,	10,424	Marblehead,	8,202	Taunton,	25,448
Cohasset,	2,448	Marlborough,	13,805	Tewksbury (State Almshouse),	–
Concord, (and Reformatory).	4,427	Maynard,	2,700	Tisbury,	1,506
Dalton,	2,885	Medford,	11,079	Tyngsborough,	662
Danvers,	7,454	Melrose,	8,519	Uxbridge,	3,408
Dedham,	7,123	Methuen,	4,814	Wakefield,	6,982
Dracut,	1,996	Middleborough,	6,065	Waltham,	18,707
East Bridgewater,	2,911	Middleton,	924	Ware,	7,329
Eastham,	602	Milford,	8,780	Warren,	4,681
Easthampton,	4,395	Millbury,	4,428	Watertown,	7,073
Easton,	4,493	Monson (State Primary School),	–	Wayland,	2,060
Everett,	11,068	Montague,	6,296	Webster,	7,031
Fall River,	74,398	Nahant,	880	Wellesley,	3,600
Fitchburg,	22,037	Nantucket,	3,268	Westborough, (and Insane Hospital).	5,195
Framingham,	9,239	Natick,	9,118	West Brookfield,	1,592
Franklin,	4,831	Needham,	3,035	Westfield,	9,805
Freetown,	1,417	New Bedford,	40,733	West Springfield,	5,077
Gardner,	8,424	Newburyport,	13,947	Weymouth,	10,866
Gill,	960	Newton,	24,379	Whitman,	4,441
Gloucester,	24,651	North Adams,	16,074	Williamstown,	4,221
Grafton,	5,002	Northampton,	14,990	Winchendon,	4,390
Great Barrington,	4,612	North Andover,	3,742	Winchester,	4,861
Greenfield,	5,252	North Attleborough,	6,727	Winthrop,	2,726
		Northborough,	1,952	Woburn,	13,499
		Northbridge,	4,603	Worcester,	84,655
		North Reading,	874		
		Norwood,	3,733		

The principal points presented with reference to each water supply are, the population of the city or town supplied, the date of introduction of water, description of the source or sources of supply, area and depth of ponds or reservoirs, general character of the water-shed or drainage area, and method of distribution. To this is appended in each case a table containing the results of the chemical and microscopical examinations of the waters, as reported by the chemists and biologists of the Board. These examinations cover a period of two years, beginning with midsummer of 1887, and form a history of the condition of the waters of the State for that period. No statements are made in this portion of the volume having reference to the quality of the water as shown by these analyses. Much information upon this point will be found in subsequent portions of the report, especially in the sections entitled "Classification of Water Supplies," "Interpretation of Analyses," and "Discussion of Special Topics," reference to which may be found in the very full and carefully prepared index at the close of the volume.

The next section contains the descriptions of the river basins of the State, also arranged in alphabetical order, the smaller tributaries being treated in connection with the rivers into which they flow. The descriptions embrace a general statement of the direction of flow of streams, the area of the water-shed, the density of the population on the drainage area, and an examination of the special sources of pollution from the manufacturing wastes upon each stream. The chemical and microscopical examinations are arranged in the same general order as in the preceding section relating to water supplies; the points at which samples were taken were selected with special reference to the object of ascertaining the character of the stream, and the effect of pollution upon it, from its source to its mouth.

The following list embraces the principal rivers which are treated in this section: —

Blackstone River.	Hoosac River.	Neponset River.
Charles "	Housatonic River.	Shawsheen "
Chicopee "	Ipswich "	Stony Brook, Boston.
Concord "	Merrimack "	Taunton River.
Connecticut "	Miller's "	Ten Mile "
Deerfield "	Nashua "	Westfield "

Professor Drown describes the method of collecting the samples and the processes employed in the chemical analysis of the waters,

and, in the section upon "Interpretation of the Chemical Analysis," discusses the question of the actual value of such analysis from a sanitary stand-point. A general classification into surface and ground waters is presented, and the relation of sewage pollution to such waters is treated. Other characteristics, such as the taste, color and odors of surface waters, are also considered. The interpretation of the chlorine and of the nitrogen compounds in water, and their value as indicative of actual sewage pollution, are fully discussed The extent of the territory covered by the water examinations of the Board, and the large number of such examinations, has enabled the chemist to present very clearly (see chlorine map facing page 680) the ratio of normal chlorine in the different regions of the State, beginning with relatively high ratios at the sea-board, and diminishing toward the western border of the State. The excess above the normal ratio becomes an index of the amount of present or previous pollution in each source, and consequently an approximate index of the population contributing such pollution.

The difficult subject of the significance of the nitrogen compounds is discussed, and the fallacy of establishing rigid standards of purity based upon them is clearly shown.

Two important conclusions are emphasized: (1) that a single determination in a chemical analysis of a water cannot inform us of its real condition; (2) that one complete analysis of a sample tells us only what the condition of the water was when the sample was taken.

Some of the contributions to present knowledge of the subject which have been developed by the chemists in the course of the study of the subject — many of them new — may be enumerated as follows: —

1. The distinction between normal and polluted waters.
2. The chemical evidence of pollution in waters.
3. Normal chlorine.
4. The idea of permanence, and of various degrees of susceptibility to decay in organic matter in water.
5. The absence of dissolved oxygen, and the putrefactive changes of organic matter in some waters at considerable depths.
6. The effect of growing plants in obliterating evidences of decay.
7. The chemical evidence of bacterial action in the state of change of organic matter.

8. The essential differences in character of surface and ground waters which influence the interpretation of analyses.

9. The influence of the season of the year on the composition of surface waters.

Mr. Parker's report deals with the organisms (bacteria excepted) which are found in the public water supplies of the State. In this portion of the volume the special topics presented are, (1) the relation of the odor in a water to the organisms which it contains, (2) the kinds of organisms found in the waters supplied to Boston, Charlestown and Cambridge, (3) the seasonal distribution of such organisms, (4) the distribution of organisms in waters variously situated, (5) an attempt at outlining a general scheme for the improvement of water made impure by organic growths, and (6) a brief account of fresh-water sponges, and their relation to water supplies. Mr. Parker's report is furnished with carefully prepared tables illustrating these special points.

In the summary of water-supply statistics, Mr. Stearns presents a brief classified statement of the water supplies of the State up to the close of the year 1889, by far the greater number of these public supplies having been introduced since 1870, previous to which year there were only twenty-four such systems of public water works in operation. Tables are also presented, in which is stated the daily amount of rainfall in each of ten places, in different parts of the State, from May 1, 1887, to May 31, 1889. To these are added further data relating to the flow of several of the rivers of the State, and observations upon the temperature of the air and of surface and ground waters, and of water as delivered to consumers. The value of these data will become evident as explaining the meteorological condition which existed when the waters referred to in the first part of this volume were examined. The effect of the depth of water in ponds upon the temperature at different seasons of the year is also graphically presented, including a special study of the same subject, as shown by observations at Jamaica Pond.

In that portion of the volume entitled "A Classification of the Drinking Waters of the State," there is presented by Mr. Mills, chairman of the committee of the Board under whose direction all of these investigations have been made, a classification of the two general groups of surface waters and of ground waters, based upon

their past or present pollution by sewage, or freedom from such pollution.

The actual condition of the drainage area of a source, and the excess of chlorine in the source beyond the normal chlorine of the waters of that region, are taken to indicate the degree of past pollution by sewage; while the present condition of the water is determined by the changes that have taken place, as shown by the present form in which nitrogen is found in the water.

The characteristics of the unpolluted waters of each group are determined, and with these are compared the forms of nitrogen of the several sources which have been polluted; and the changes that have taken place under the existing circumstances are traced, as completely as practicable, from the entrance of pollution to the conditions existing in the supply. By this study, it is found that nearly one-half of all the water supplies of the State have not been polluted by sewage; that a large part of the remainder have been so purified by filtration through the ground, or by the appropriation of the impurities by organic growth, that they cannot be regarded as deleterious to health. A small number remain whose condition is doubtful or dangerous, and these demand further investigation.

The discussion of "Special Topics relating to the Quality of Water Supplies" contains much information which has a practical bearing upon the selection of sources of public water supply, and the methods of storage both of ground and of surface waters. Several supplies have been selected and made the subject of careful and continuous examination, both chemical and biological, and the results are grouped together and tabulated in this section of the report. Special prominence is given to the effect of storage upon the color, taste and odor of water, as well as the chemical composition.

A portion of this section of the report is devoted to the investigation of the character of the water in deep ponds, at different depths and at different seasons of the year. The variations in the nitrogen compounds at different depths and at different seasons of the year in Jamaica Pond are presented in a series of tables and diagrams.

Several surface waters which have caused serious annoyance, from the periodical development of aquatic organisms, have been made

the subject of investigation, and the results are presented in this part of the report. This section closes with a general statement of the results of observation upon the natural filtration of water in several places in the State. To this is added a statement of the characteristics of the troublesome *Crenothrix*.

In the chapter entitled "The Pollution and the Self-purification of Streams," these kindred subjects are presented by the engineer of the Board, and observations are given upon the condition of some of the principal streams of the State, large and small, into which sewage is continuously discharged. Observations upon this point in other States and countries are not very numerous, so that standards of comparison are not easily obtained. The analyses of the sewage of London, by the Metropolitan Commission of 1884, are compared with those of Lawrence and of Worcester. Tables are presented giving the estimated composition of sewage under different degrees of dilution, and the amounts of the ammonia, solids and chlorine added to streams by domestic sewage for various ratios of population to the quantity of water flowing in such streams.

The subject of the "self-purification" of streams is treated mainly from a chemical stand-point, the rivers taken as illustrative examples being the Blackstone, between Worcester and Millville; the Merrimack, from Nashua to Haverhill; and Beaver Dam Brook, in Framingham, which receives the water of the underdrain of the sewerage system of that town.

This chapter forms an appropriate connecting link between the first volume, upon water supplies and other kindred topics, and the second volume, which relates to the general subject of the purification of sewage.

The SECOND VOLUME contains the methods and results of the experimental investigations of the Board, upon the purification of sewage by filtration and by chemical precipitation, and upon the intermittent filtration of water, made at the experiment station at Lawrence in 1888, 1889 and 1890.

These investigations have been made under the direction and the continuous supervision of Mr. Hiram F. Mills, the engineer member of the Board, whose elaborate report forms the principal part of the volume.

This report first gives a description of the experiment station and states the object of the work: which is, to determine the fundamental principles of filtration not previously established, and to learn what can practically be accomplished by filters made of some of the widely varying materials found in suitable localities for filtration areas, that there may be deduced from these results, together with the quality and physical characteristics of the materials used, the probable efficiency of other materials to be found throughout the State.

The method of recording and the meaning of the results of analyses are then presented; after which follow the results obtained with each of thirty-two different filters.

A description is given of the material of which each filter is composed, including the sizes of the grains of sand or other material, and other physical characteristics which affect its ability as a filter, together with some of its chemical constituents, in order that the filtering capacity of materials, having similar characteristics, may be determined from the experimental results obtained.

While deductions are fully made in the light of this beginning of the science of filtration, all of the data of chemical and biological analysis, and, as far as may be, the attendant circumstances, are recorded, that they may serve the future student as the means of verification or of correction in the greater light which further investigation may give him.

In the presentation of these results, and their discussion, many additions to the knowledge of the world upon this important subject of purification of sewage by filtration are given.

The distinctive and essential differences between continuous and intermittent filtration are presented by alternately using one method and then the other, upon the same filter, with the same daily quantity of sewage.

The dependence of the efficiency of intermittent filtration of sewage upon the process of nitrification (a process which does not occur in continuous filtration); the conditions favorable to the process of nitrification, its dependence upon nitrifying organisms, and the condition of the surface and degree of saturation of the filtering material, are brought out by many examples, throwing much light upon the subject. It is shown that while nitrifying bacteria are necessary, in producing nitrification, the process of complete nitrification of the organic matter of the sewage is one of

complete destruction of other bacteria and, presumably, of all disease germs. And finally it is shown that the process of purification of sewage by intermittent filtration is in no essential sense a straining process, but is thoroughly complete when sewage passes down through a mass of coarse gravel stones in very slow motion, in extremely thin films over the surface of each stone, exposed to air, with the nitrifying bacteria attached to the surface of the stones. The latter come in the sewage, and the conditions named are favorable to their existence and to the accomplishment of their work.

The practical conditions under which sewage in large quantities may be filtered to be made suitable to turn into a stream not used for drinking, and the conditions necessary for rendering the effluent entirely suitable to be turned into a drinking-water stream by the complete purification of sewage from all bacteria that can be determined by the usual methods of culture, and presumably from all disease germs, are for the first time made known.

The results of experiments in the year 1890 are given in briefer form than those of the previous two years, and show in general that much larger quantities of sewage may be efficiently purified by systematically raking over the surface of the filter.

Very interesting results upon the intermittent filtration of water are presented and the conditions favorable for good results worked out.

With about three hundred thousand gallons of city water filtered daily, for six days in the week, upon an acre, it is believed that all of the bacteria present in the water were killed, and that none of them came down through the filter.

With larger quantities, through more open filters, some of the bacteria came through. In other respects the water was much improved in quality when filtering one million and two million gallons per acre per day, until the quantity of two hundred or three hundred million gallons of water had been filtered upon an acre. Experiments are in progress to learn how to extend the life of such filters.

This report of Mr. Mills concludes with a summary account of the results of the experiments upon the purification of sewage by chemical precipitation.

In the report of the chemists of the Board, Prof. T. M. Drown and Mr. Allen Hazen, are given the methods used in the analysis of the sewage and effluents, and also an account of some investigations into the nature of the changes which nitrogenous matter undergoes in the process of oxidation. These investigations include many specially-

designed experiments on the filtration of sewage under various conditions, and of solutions of organic and ammoniacal compounds of known composition. These investigations have given us much valuable information about the process of nitrification, which has direct practical bearing on the problem of sewage disposal by intermittent filtration.

In Mr. Hazen's report on the Chemical Precipitation of Sewage will be found an account of an extended series of experiments on the treatment of sewage by chemical precipitants. The results obtained are an important contribution to our knowledge of this subject, since they show the relative advantages and cost of different precipitants on sewage of the same composition.

The report of the biologist (Professor Sedgwick), upon the biological aspects of the work of the station, begins with a full account of the methods employed in this new branch of sanitary science. Special attention is given to the microscopical as well as the bacteriological methods of research, and a new and trustworthy quantitative method of microscopical analysis is described in detail. It is believed that the work of the Board in this direction is unique and noteworthy. One section of the report deals with the micro-organisms of sewage, establishing important and accurate data for future use. It is immediately followed by a special report by the chief assistant biologist (Mr. Edwin O. Jordan) upon the kinds of bacteria which occur in sewage. Of these, twelve species have been subjected to the most thorough investigation, and full descriptions, with illustrations made from photo-micrographs, make this paper a contribution to our knowledge of the bacterial flora and the essential nature of sewage. The illustrations deserve special notice, and testify to the skill of Dr. R. R. Andrews of Cambridge, Mass., by whom the photo-micrographs were taken.

The general phenomena of intermittent filtration are next described from the biological stand-point, and in the following section certain puzzling relations of the organisms to the rate of flow are explained and elucidated.

It has long been a question whether or not bacteria can pass through sand filters, and the question is one of immediate practical importance as bearing on the possibility of the complete removal of disease germs by filtration. The report of the biologist makes it manifest that some species do pass, though with difficulty, through filters of coarse sand, but probably fail to pass through those com-

posed of very fine sand. These experiments appear, moreover, to be the first of an absolutely conclusive character ever made. The results of special investigations upon the influence of certain important substances of a class likely to occur in sewage (alkali, salt, acid, etc.) are next detailed, and some space is given to the filtration of water and the chemical precipitation of sewage. Finally, the biological aspects of the theory of intermittent filtration are treated, and the principles involved are discussed in the light of all the results, with a view to their ready practical application.

The volume ends with a report by Mr. Edwin O. Jordan and Mrs. Ellen H. Richards upon certain investigations, made by them in connection with the regular work of the Board, upon nitrification and the nitrifying organism. The processes of change which take place in the organic contents of natural waters and in soils have always been recognized as important but have hitherto been exceedingly obscure. The fortunate co-operation of the chemical and biological laboratories, made possible by the investigations of the Board, has borne fruit in a valuable contribution to our knowledge of the causes and conditions of nitrification, in the study of which real progress has been made. The isolation of the nitrifying organism is here reported probably for the first time in America.

H. P. WALCOTT,
J. H. APPLETON,
E. U. JONES,
J. W. HASTINGS, *State Board of Health.*
H. F. MILLS,
F. W. DRAPER,
J. M. RAYMOND,

[Chap. 375 of the Acts of 1888.]

AN ACT to protect the Purity of Inland Waters, and to require Consultation with the State Board of Health regarding the Establishment of Systems of Water-supply, Drainage and Sewerage.

Be it enacted, etc., as follows:

Section 1. The state board of health shall have the general oversight and care of all inland waters, and shall be furnished with maps, plans and documents suitable for this purpose, and records of all its doings in relation thereto shall be kept. It may employ such engineers and clerks and other assistants as it may deem necessary: *provided*, that no contracts or other acts which involve the payment of money from the treasury of the Commonwealth shall be made or done without an appropriation expressly made therefor by the general court. It shall annually on or before the tenth day of January report to the general court its doings in the preceding year, and at the same time submit estimates of the sums required to meet the expenses of said board in relation to the care and oversight of inland waters for the ensuing year, and it shall also recommend legislation and suitable plans for such systems of main sewers as it may deem necessary for the preservation of the public health, and for the purification and prevention of pollution of the ponds, streams and inland waters of the Commonwealth.

Sect. 2. Said board shall from time to time, as it may deem expedient, cause examinations of the said waters to be made for the purpose of ascertaining whether the same are adapted for use as sources of domestic water-supplies or are in a condition likely to impair the interests of the public or persons lawfully using the same, or imperil the public health. It shall recommend measures for prevention of the pollution of such waters, and for removal of substances and causes of every kind which may be liable to cause pollution thereof, in order to protect and develop the rights and property of the Commonwealth therein and to protect the public health. It shall have authority to conduct experiments to determine the best practicable methods of purification of drainage and sewage or disposal of the same. For the purposes aforesaid it may employ such expert assistance as may be necessary.

Sect. 3. It shall from time to time consult with and advise the authorities of cities and towns, or with corporations, firms or individuals either already having or intending to introduce systems of water-supply, drainage or sewerage, as to the most appropriate source of supply, the best practicable method of assuring the purity thereof or of disposing of their drainage or sewage, having regard to the present and prospective needs and interest of other cities, towns, corporations, firms or individuals which may be affected thereby. It shall also from time to time consult with and advise persons or corporations engaged or intending to engage in any manufact-

uring or other business, drainage or sewage from which may tend to cause the pollution of any inland water, as to the best practicable method of preventing such pollution by the interception, disposal or purification of such drainage or sewage: *provided*, that no person shall be compelled to bear the expense of such consultation or advice, or of experiments made for the purposes of this act. All such authorities, corporations, firms and individuals are hereby required to give notice to said board of their intentions in the premises, and to submit for its advice outlines of their proposed plans or schemes in relation to water-supply and disposal of drainage and sewage, *and all petitions to the legislature for authority to introduce a system of water-supply, drainage or sewerage shall be accompanied by a copy of the recommendation and advice of the said board thereon.* Said board shall bring to the notice of the attorney-general all instances which may come to its knowledge of omission to comply with existing laws respecting the pollution of water-supplies and inland waters, and shall annually report to the legislature any specific cases not covered by the provisions of existing laws, which in its opinion call for further legislation.

SECT. 4. In this act the term "drainage" refers to rainfall, surface and subsoil water only, and "sewage" refers to domestic and manufacturing filth and refuse.

SECT. 5. Chapter two hundred and seventy-four of the acts of the year eighteen hundred and eighty-six is hereby repealed, but nothing in this act shall be construed to affect the expenditures authorized under chapter thirty of the resolves of the year eighteen hundred and eighty-eight.

SECT. 6. This act shall take effect upon its passage. [*Approved May 18, 1888.*

Part I.

EXAMINATIONS OF WATER SUPPLIES AND RIVERS.

WATER SUPPLIES.

DESCRIPTIONS OF WATER WORKS; CHEMICAL AND BIOLOGICAL EXAMINATIONS OF PRESENT SOURCES OF WATER SUPPLY AND OTHER INLAND WATERS.

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EXPLANATORY NOTE.

The following tabulations, giving descriptions of works, chemical analyses, microscopical examinations and other information, are arranged alphabetically by towns.

Analyses of water from any source used for water supply are tabulated under the name of the town supplied, while those from sources not used for water supply are arranged under the town in which the sample of water was collected.

An exception to this rule has been made where water from several sources has been examined in connection with an investigation of a present or proposed water supply, in which case the analyses are generally given under the name of the town interested in the supply.

The analyses of the water of streams not used for water supply are generally omitted from this tabulation by towns, as they appear in a subsequent tabulation in connection with a discussion of the waters of the river basins.

The descriptions of the water-works have been compiled chiefly from returns made to the State Board of Health by the water-works officials and from their published reports. Some of the information, however, is the result of personal investigation by members of the engineering force of the Board. In many cases the areas of water-sheds have been measured from the new topographical map of the State, the boundary line being traced from the features shown on the map and not from reconnoissance upon the ground. Where the water-sheds are in a hilly country and not too small, this method gives satisfactory results; but in other cases the areas, as given, may not be quite accurate.

As a rule one or more samples from each source have been collected by an agent of the State Board of Health. The bulk of the samples, however, have been collected by persons connected with the water-works.

In the tables of chemical analyses the figures in common type indicate determinations made on the water as received; that is to say, they include the suspended

matters and sediment, while the figures in heavy-faced type indicate determinations made on the water after it has been filtered through paper in the laboratory. A few cases will be noted in the tabulated results, in which one or more chemical determinations differ somewhat widely from others in the same series. Such a condition of the water might result from floods or other unusual disturbance of a stream, or from carelessness in collection, or an error may have been made in the analysis. In such cases the determination has been underlined and has not been included in the average. Where the determinations of the loss on ignition and fixed residue are underlined, the corresponding total residue is omitted from the average.

No attempt has been made to give the character of the waters in connection with the tabulated results of the analyses. In the subsequent general discussion of the water supplies, the qualities and peculiarities of many of the waters will be referred to more or less at length. For the characters of those waters which are not especially mentioned in this discussion, the reader is referred to that portion of the report which deals with the "interpretation of analyses."

In addition to the determinations given in the tables each sample has been examined for its odor, both cold and hot. The complete record of these odors it was thought unnecessary to include in the table, but mention of their general character is made in the foot-note after the chemical results. The hardness of the waters has been determined once for each water, and is given in the foot-note. The appearance and odor on ignition of the solid residue of evaporation was also determined in each sample, but this record is not in the tables, since the significance of these determinations is, in most waters, of subordinate importance.

The color of the waters is expressed by numbers which increase with the amount of color. Water having a color of 1.0 is a decided yellowish brown when seen in small bulk, as in a tumbler. As a standard of comparison, it may be mentioned that the color of water from the Cochituate works, as drawn from a tap at the Massachusetts Institute of Technology, is generally about 0.35.

The "loss on ignition" is not given in the analyses of ground waters, since it bears little or no relation to the amount of organic matter present in the water. This subject will be fully discussed in the section of the report devoted to "methods of analysis."

Averages have been made of the chemical determinations in the tables as a matter of convenience for those who wish to study the results. In many cases the averages are for a less period than a year, and in others for a period between one and two years. In these cases the averages cannot, obviously, express a mean yearly composition of the water. The averages of the determinations expressed in heavy-faced type are not given except when these determinations have been made for all samples in the table.

The microscopical examination of water from a few sources was begun in July, 1887; but the systematic examination of all the waters was not undertaken until March, 1888. After this time a sample for microscopical examination was taken from each bottle of water received at the chemical laboratory. The standard quantity of water used in an examination was 200 cubic centimetres. From March 16 to June 5, 1888, the quantitative estimate of the organisms was expressed by adjectives indicating their relative abundance.

Since June 5, 1888, greater care has been taken to determine the number of organisms of each kind removed by filtration from the 200 cubic centimetres of

water, and the results are recorded in figures, showing the numbers found. The method of filtration adopted did not permit all of the organisms contained in the water to be transferred to the slide for examination, and the figures given should not therefore be considered as representing more than a part of the total number of organisms in 200 cubic centimetres of water. While the method, therefore, lacks quantitative accuracy, the results obtained by it since June, 1888, express very much better the relative number of organisms in the waters than the results recorded before this time. The results obtained under the earlier system are, as a rule, only given where subsequent examinations by the newer system have not been made. In tabulating the results of the microscopical examinations for this report, the unit used is 1,000 organisms. One-tenth, the smallest figure given, therefore represents 100. Any smaller number is indicated by the letters pr., an abbreviation for the word present.

The statements of the results of the microscopical examinations which follow the tables of chemical analyses, are in two forms. In the first, the results are arranged by months; and since the chemical and biological examinations were made with water from the same bottle, the results given for the same month and year by these examinations are directly comparable. In the first form the organisms have been grouped under four heads: three of these, namely, the blue-green algæ, other algæ and fungi, represent the plants; the fourth includes all animals. The second form is an enumeration of the groups and principal genera of organisms which have been observed. The names of the genera have been printed in italics and signify that at least in one examination the organism designated by the name has been present in as great a number as 1,000. The names of the groups of organisms have been printed in Roman type. When a group is named but no genus is mentioned under it, it is understood that the group is represented by a genus or by genera the individual representatives of which have been present at no examination in as great a number as 1,000. The figures 1, 2, 3 and 4 have been used in the second form to classify the groups in sections which correspond to the four heads of the first form. The greatest number of groups which will be found in the second form and the relation which these bear to the four heads of the first form can be seen in the following enumeration. 1, Cyanophyceæ (blue-green algæ). 2, Palmellaceæ, Zoosporeæ, Desmidiaceæ, Diatomaceæ, Zygnemaceæ, Volvocineæ. 3, Schizomycetes. 4, Protozoa, Spongiaria, Hydrozoa, Nematoda, Annelida, Rotifera, Entomostraca, Bryozoa.

The necessity for printing this tabulation before the reports and discussions which follow it are in type, prevents reference from being made to the pages where the different water supplies are discussed. The reader desiring to find these discussions is therefore referred to the index to be found at the end of the volume.

WATER SUPPLIES.

DESCRIPTIONS OF WATER WORKS; CHEMICAL AND BIOLOGICAL EXAMINATIONS OF PRESENT SOURCES OF WATER SUPPLY AND OTHER INLAND WATERS.

Water Supply of Abington and Rockland.

Description of Works. — Population in 1885: Abington, 3,699; Rockland, 4,785; total, 8,484. The main works are owned jointly by the towns of Abington and Rockland, but each town owns and controls independently its distributing system. Water was introduced in January, 1887. The daily average consumption in 1888 was 248,143 gallons. The source of supply is Big Sandy Pond in Pembroke: area of pond, estimated from new topographical map of Massachusetts, 111 acres; general depth, 15 feet; maximum depth, 20 feet, bottom, sandy. The drainage area is uninhabited and is covered with woods. Water is drawn from the pond at a point about 140 feet from shore, and the inlet is so arranged that water may be drawn from any depth not exceeding 6½ feet below high water. Pumps force the water from the pond to an open iron tank 100 feet high and 25 feet in diameter. Distributing mains are of cast iron; service pipes are of wrought iron, lined with cement. A filter-gallery was at first attempted along the shore of the pond, but "after an excavation of the proposed dimensions had been made, it was evident from daily trial that, by reason of the fineness of the sand, the water would not filter through in sufficient quantities to supply the pumps and the plan was abandoned." The filter-gallery was completed as proposed, and is used as a pump well.

Chemical Examination of Water from Big Sandy Pond, in Pembroke.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
67	June 9	June 11	- -	- -	0.25	4.15	1.47	2.68	.0022	.0159	.56	.0070	-
293	July 8	July 9	Slight.	Slight.	0.10	3.52	0.92	2.60	.0001	.0150	.56	.0030	-
485	Aug. 5	Aug. 6	Very slight.	None.	0.30	3.10	0.77	2.33	.0002	.0151	.54	.0070	-
700	Sept. 6	Sept. 7	Slight.	None.	0.20	3.07	0.72	2.35	.0008	.0112	.60	.0070	-
893	Oct. 5	Oct. 6	Very slight.	None.	0.25	3.30	0.80	2.50	.0017	.0179	.64	.0040	-
894	Oct. 5	Oct. 6	None.	Very slight.	0.05	3.50	0.80	2.70	.0000	.0178	.61	.0040	-
	1888.												
1583	Jan. 11	Jan. 12	Very slight.	Very slight.	0.05	3.50	0.85	2.65	.0005	.0143	.63	.0080	.0001
1584	Jan. 11	Jan. 12	Slight.	Very slight.	0.10	3.25	0.90	2.35	.0017	.0195	.63	.0080	.0001
1758	Feb. 5	Feb. 7	Slight.	Very slight.	0.10	3.30	0.80	2.50	.0010	.0142	.46	.0060	.0001
1759	Feb. 6	Feb. 7	Slight.	Very slight.	0.10	3.30	0.80	2.50	.0003	.0154	.54	.0070	.0000
2206	Apr. 12	Apr. 13	Distinct.	Very slight.	0.15	2.95	0.80	2.15	.0000	.0192	.57	.0080	.0001
Av.	....	....	....	....	0.15	3.36	0.88	2.48	.0008	.0160	.58	.0063	.0001

Odor, generally none, sometimes vegetable.——The samples were collected from a faucet at the pumping station, while pumping, with the exception of Nos. 894 and 1583, collected from main pipe in Abington, and of No. 1759, collected from main pipe and representing water which had been standing in the iron tank.

Microscopical Examination.

April, 1888. Blue-green algæ, very few. Other algæ, present in moderate numbers.

Groups and principal genera of organisms observed: 1, Cyanophyceæ. 2, Diatomaceæ, *Asterionella*, *Melosira*, *Tabellaria*.

Water Supply of South Adams Fire District, Adams.

Description of Works. — Population of Adams in 1885, 8,283. Estimated population supplied in 1887, 8,000. Works are owned by the Fire District. Water was introduced in 1874. The ordinary sources of supply are Bassett and Dry brooks, on each of which a small storage reservoir is built. Bassett Brook Reservoir has a capacity of about five million gallons and is situated southwesterly from the town. Its drainage area, of about 2.6 square miles (estimated from the new topographical map of Massachusetts), is steep, wooded and rocky, but is said to be free from limestone. Dry Brook Reservoir has a capacity of about five million gallons and is situated southeasterly from the town. Its drainage area, of 7.84 square miles (estimated as above), is steep and well wooded, but

contains also a little pasture land. It is rocky and much of the rock is said to be limestone. Both drainage areas are almost uninhabited. Provision is made for supplementing the supply during droughts by pumping from the wells of the Renfrew Manufacturing Company. Water from the brooks is distributed by gravity. Distributing mains are of cast iron.

Chemical Examination of Water from Bassett Brook Storage Reservoir.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
59	June 8	June 9	None.	Very slight.	0.10	3.30	1.05	2.25	.0030	.0090	.07	.0070	-
292	July 8	July 9	None.	None.	0.00	3.45	0.55	2.90	.0002	.0064	.11	.0130	-
479	Aug. 4	Aug. 5	None.	None.	0.00	3.95	0.57	3.38	.0008	.0039	.09	.0200	-
709	Sept. 6	Sept. 8	Distinct.	Slight.	0.00	4.65	0.30	4.35	.0004	.0040	.09	.0130	-
910	Oct. 8	Oct. 10	Very slight.	Considerable.	0.10	5.30	0.40	4.90	.0008	.0047	.05	.0070	-
1322	Dec. 5	Dec. 6	Distinct.	Considerable.	0.20	4.05	1.15	2.90	.0011	.0172	.04	.0170	-
Av.	....	....	....	....	0.07	4.12	0.67	3.45	.0011	.0075	.08	.0128	-

Odor, none.——The samples were collected from the reservoir. No. 1322 was collected while brook was swollen by heavy rains of December 4 and 5.

Chemical Examination of Water from Dry Brook Storage Reservoir.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
60	June 8	June 9	None.	Slight.	0.20	7.02	1.27	5.75	.0008	.0101	.10	.0070	-
291	July 8	July 9	Very slight.	Slight, brown.	0.20	8.05	1.65	6.40	.0025	.0120	.10	.0070	-
480	Aug. 4	Aug. 5	Slight.	None.	0.45	9.10	1 83	7.27	.0030	.0165	.09	.0070	-
708	Sept. 6	Sept. 8	Very slight.	Very slight.	0.10	7.57	0.45	7.12	.0009	.0094	.09	.0070	-
911	Oct. 8	Oct. 10	None.	Very slight.	0.40	8.15	1.45	6.70	.0000	.0112	.10	.0030	-
1323	Dec. 5	Dec. 6	Very slight.	Considerable, gray.	0.10	5.10	1.10	4.00	.0000	.0075	.05	.0100	-
Av.	....	....	....	....	0.24	7.50	1.29	6.21	.0012	.0111	.09	.0068	-

Hardness in June, 5.1. Odor, none.——The samples were collected from the reservoir. No. 1323 was collected while brook was swollen by heavy rains of December 4 and 5.

Water Supply of Agawam.

Description of Works. — Population in 1885, 2,357. Works are owned by C. L. Goodhue. Water was introduced in 1877. About fifty families were supplied in 1888. The source of supply is a spring in Agawam. Water is distributed by gravity. Distributing mains and service pipes are of wrought iron, lined with cement.

Chemical Examination of Water from Spring, Agawam Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
136	June 17	June 18	Slight, milky.	Much, rusty.	0.0	3.87	-	-	.0000	.0024	.14	.0000	-
381	July 21	July 22	None.	Very slight.	0.0	3.17	-	-	.0020	.0021	.17	.0130	-
569	Aug. 16	Aug. 18	None.	Very slight, earthy.	0.0	2.97	-	-	.0000	.0002	.12	.0000	-
1373	Dec. 8	Dec. 10	Very slight.	Considerable, earthy.	0.0	2.95	-	-	.0000	.0032	.11	.0030	-
	1888.												
1839	Feb. 15	Feb. 16	None.	Very slight	0.0	2.90	-	-	.0010	.0012	.13	.0100	.0001
2249	Apr. 18	Apr. 19	None.	Very slight, white.	0.0	2.95	-	-	.0004	.0012	.17	.0100	.0000
2437	May 16	May 17	None.	Very slight, earthy.	0.0	3.20	-	-	.0000	.0000	.12	.0200	.0000
Av.	....	....	....	....	0.0	3.14	-	-	.0005	.0015	.14	.0080	-

Hardness in May, 1.4. Odor, none.——The samples were collected from a faucet in the village.

Microscopical Examination.

April, May, 1888. An insignificant number of algæ present. Groups of organisms observed: 2, Zoosporeæ; Diatomaceæ.

Water Supply of Amesbury. — Powow Hill Water Company.

Description of Works. — Population in 1885, about 8,043. Works are owned by the Powow Hill Water Company. The company was chartered to supply Amesbury and Salisbury; but the principal part of Salisbury, including the villages of Salisbury and Salisbury Point, was annexed to Amesbury by an act of the Legislature in 1886. Water was introduced in 1885. The daily average consumption in 1887 was about 100,000 gallons. The source of supply at first was a tubular well system, consisting of 36 tubular wells, 45 feet deep. This source proved inadequate and

was abandoned, and the sources which furnish the water at the present time were selected. These sources of supply are 14 tubular wells, each two inches in diameter, sunk in the bottom of an open basin. The basin is 14 feet deep and the wells are sunk to a depth of 16 feet below its bottom. There is also a supplementary basin 80 feet long and 40 feet wide. Pumps force the water to an open distributing reservoir, having a capacity of 500,000 gallons. There is also a high-service reservoir, having a capacity of 1,500,000 gallons, which is used for fire purposes only and is filled but twice a year. Distributing mains are of cast iron, and service pipes of wrought iron, cement lined.

Chemical Examination of Water from Tubular Wells supplying Open Basin.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Exam-ination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albu-minoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
75	June 10	June 11	Decided, milky.	Very slight.	0.0	–	–	–	.0006	.0033	.51	.0720	–
294	July 9	July 9	Decided, milky.	None.	0.0	7.64	–	–	.0002	.0104	.58	.0260	–
482	Aug. 5	Aug. 6	Slight, milky.	None.	0.0	7.40	–	–	.0002	.0041	.54	.0980	–
693	Sept. 6	Sept. 7	Slight.	Very slight.	0.0	6.37	–	–	.0004	.0048	.51	.0910	–
892	Oct. 5	Oct. 6	None.	Very slight.	0.0	4.85	–	–	.0026	.0114	.43	.0520	–
1111	Nov. 7	Nov. 8	Very slight.	None.	0.0	5.75	–	–	.0000	.0026	.44	.0800	–
1342	Dec. 7	Dec. 8	Very slight.	None.	0.0	6.15	–	–	.0000	.0040	.44	.0800	–
	1888.												
1539	Jan. 5	Jan. 6	Very slight.	None.	0.0	6.20	–	–	.0000	.0012	.45	.0800	.0001
1744	Feb. 3	Feb. 4	Slight, milky.	Slight, earthy.	0.0	6.15	–	–	.0002	.0030	.43	.0650	.0001
1958	Mar. 6	Mar. 7	Very slight, milky.	Very slight.	0.0	6.25	–	–	.0016	.0046	.45	.0750	.0001
2165	Apr. 7	Apr. 9	Very slight.	Very slight.	0.0	5.75	–	–	.0000	.0044	.41	.0700	.0000
2218	Apr. 14	Apr. 14	Very slight	None.	0.0	5.80	–	–	.0000	.0014	.43	.0800	.0001
2397	May 10	May 11	None.	None.	0.0	6.10	–	–	.0000	.0000	.42	.0650	.0000
Av.	....	....	....	....	0.0	6.20	–	–	.0004	.0042	.46	.0718	.0001

Hardness in May, 1888, 3.0. Odor, sometimes none, occasionally vegetable and disagreeable.—— The samples were collected from the open basin, with the exception of Nos. 1539 and 2218, which were collected from a faucet at the pumping station while pumping; and No. 2397, which was collected from a faucet in the pumping station after pumping had ceased. No. 75 was collected at a time when the basin was being repaired, and the water contained much clay.

Microscopical Examination.

April, 1888. An insignificant number of algæ present. May, 1888. Blue-green algæ, very few. Other algæ present. Groups of organisms observed: 1, Cyanophyceæ. 2, Diatomaceæ.

Chemical Examination of Water from Low-service Distributing Reservoir, Amesbury.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.	1888.											
1549	Jan. 6	Jan. 7	Very slight, milky.	Very slight.	0.0	6.15	–	–	.0000	.0078	.44	.0700	.0000
1745	Feb. 3	Feb. 4	Slight, milky.	Very slight.	0.0	6.05	–	–	.0000	.0012	.41	.0650	.0001
2219	Apr. 14	Apr. 14	None.	None.	0.0	5.90	–	–	.0000	.0008	.42	.0650	.0001
2366	May 7	May 8	Very slight, milky.	Slight.	0.0	6.15	–	–	.0014	.0080	.47	.0450	.0003
Av.	....	....	....	....	0.0	6.06	–	–	.0004	.0045	.44	.0612	.0001

Hardness in May, 2.6. Odor, very faint or none. —— Nos. 1549 and 2366 were collected directly from the reservoir; Nos. 1745 and 2219 were collected from faucets near the reservoir, but do not, probably, represent water that had been standing in the reservoir.

Microscopical Examination.

April, May, 1888. An insignificant number of algæ present. Groups of organisms observed: 2. Zoosporeæ; Diatomaceæ.

Water Supply of Amherst. — Amherst Water Company.

Description of Works. — Population in 1885, 4,199. Works are owned by the Amherst Water Company. Water was introduced in 1880. There were about 265 service taps in 1887. There are two sources of supply, formerly owned by different companies, but now belonging to the Amherst Water Company. The principal source of supply is Amethyst Brook, in Pelham, on which a small storage reservoir is built. The average depth of this reservoir is about nine feet and the bottom is of gravel. The drainage area is rocky and hilly. Water is distributed by gravity. Distributing mains are of wrought iron, lined with cement, and of cast iron; service pipes are of wrought iron. The second source of supply is a small, covered reservoir, fed by springs or wells, located in Pelham. Water from this source was introduced in 1887. The reservoir is 70 feet long, 40 feet wide and 6 feet deep. The springs or wells are seven in number, and are all covered. Water flows by gravity from the wells to the reservoir, and thence to the town. The distributing mains and service pipes of this system are of wrought iron, tarred.

Chemical Examination of Water from Amethyst Brook Storage Reservoir.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Exam-ination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albu-minoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
178	June 22	June 24	Very slight.	Very slight.	0.30	4.70	1.12	3.58	.0005	.0098	.15	.0130	-
395	July 23	July 25	Very slight.	None.	1.20	4.80	1.67	3.13	.0012	.0218	.12	.0130	-
840	Sept. 21	Sept. 23	None.	None.	0.50	3.60	0.95	2.65	.0000	.0079	.10	.0030	-
1206	Nov. 16	Nov. 17	Distinct.	Very slight.	1.20	4.70	1.50	3.20	.0002	.0153	.19	.0080	-
	1888.												
1682	Jan. 24	Jan. 25	None.	Slight, black.	0.25	3.20	0.95	2.25	.0000	.0054	.06	.0120	.0000
2121	Mar. 28	Mar. 30	Slight.	Very slight.	0.30	2.30	0.90	1.40	.0000	.0072	.07	.0050	.0000
2528	May 28	May 29	None.	None.	0.40	2.55	0.95	1.60	.0000	.0088	.08	.0050	.0001
Av.	....	....	....	....	0.59	3.69	1.15	2.54	.0003	.0109	.11	.0084	-

Hardness in May, 1.3. Odor, generally none.——The samples were collected from a faucet in the village. The dam of the Amherst Water Company was carried away in the latter part of August, 1887, and was rebuilt. A small dam above the reservoir was carried away Nov. 15, 1887, which may have affected the sample collected the next day.

Microscopical Examination.

March, May, 1888. An insignificant number of organisms present.

Chemical Examination of Water from Springs in Pelham.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Exam-ination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albu-minoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
179	June 22	June 24	None.	None.	0.00	3.15	-	-	.0000	.0014	.10	.0060	-
430	July 27	July 29	Very slight.	None.	0.00	3.17	-	-	.0000	.0012	.14	.0130	-
746	Sept. 12	Sept. 13	Very slight.	None.	0.00	3.45	-	-	.0000	.0013	.10	.0070	-
832	Sept. 19	Sept. 22	None.	Consid'ble.	0.00	3.40	-	-	.0000	.0045	.13	.0030	-
	1888.												
1683	Jan. 24	Jan. 25	None.	None.	0.25	2.80	-	-	.0000	.0050	.04	.0090	.0000
2322	Apr. 26	Apr. 27	Very slight.	Very slight.	0.00	1.90	-	-	.0004	.0010	.07	.0020	.0000
Av.	....	....	....	....	-	2.98	-	-	-	.0024	.10	.0067	-

Odor, generally none.——The samples were collected from a faucet in the village.

Microscopical Examination.

April, 1888. Diatomaceæ present in insignificant numbers.

Water Supply of Arlington.

Description of Works. — Population in 1885, 4,673. Works are owned by the town. Water was introduced in 1872. The source of supply is a storage reservoir on North Brook, in Lexington : area, 31 acres ; average depth, about 8 feet ; capacity, 77,000,000 gallons ; bottom, muddy. The drainage area is about 2,700 acres. A large part of it is meadow land, and the remainder cultivated land and pasture, with some wood land. There are very few dwellings on the drainage area. A reserve reservoir, made by flowing Great Meadows, in Lexington, to a slight depth, is drawn upon when needed. Generally the water from this reservoir is allowed to flow past the main reservoir into the brook below it. In 1876 "the water commissioners, hearing many complaints about the quality of the water and learning that some persons were relinquishing its use," built a filter-gallery near the upper end of the reservoir. In 1877 and 1883 additions to the gallery were built, so that at the present time the filtering plant comprises a gallery 235 feet long, on the shore of the reservoir near the upper end ; a gallery 150 feet long, beneath the bottom of the reservoir, connected with the first by a smaller gallery 375 feet long ; and, finally, a gallery below the dam 98 feet long, connected with the others by a brick conduit with plank bottom. From the last-mentioned gallery, water is drawn into the main supply pipe to the town. At some seasons of the year the galleries do not furnish a sufficient supply for the town, and water is drawn directly from the reservoir. Water is distributed by gravity. Distributing mains and service pipes are of wrought iron, lined with cement. For extensions to distributing mains cast iron is now used.

Chemical Examination of Water from Arlington Filter Gallery.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1887.												
79	June 10	June 11	Decided, milky.	Very slight	0.50	6.45	1.92	4.53	.0206	.0135	.70	.0260	–
528	Aug. 12	Aug. 12	Decided.	Considerable.	0.60	7.30	2.20	5.10	.0137	.0332	.75	.0000	–
1421	Dec. 15	Dec. 16	Decided, opalesce't.	Slight.	0.30	7.45	1.80	5.65	.0252	.0166 .0110	.83	.0420	–
	1888.												
1593	Jan. 14	Jan. 14	Decided, opalesce't.	Con., earthy and floc't	0.20	6.95	1.35	5.60	.0240	.0128	.67	.0800	.0000

Chemical Examination of Water from Arlington Filter Gallery — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
2166	Apr. 9	Apr. 9	Decided.	Considerable.	0.35	6.40	1.10	5.30	.0162	.0123	.52	.1000	.0001
2426	May 14	May 15	Distinct, milky.	Very slight.	0.20	6.25	1.50	4.75	.0104	.0086 .0086	.46	.0900	.0004
2618	June 15	June 16	Decided, milky.	Slight, white.	0.20	6.50	1.95	4.55	.0258	.0176 .0130	.58	.0300	.0004
2777	July 14	July 14	Decided, milky.	Considerable.	0.15	7.60	1.55	6.05	.0230	.0192 .0142	.67	.0500	.0006
2913	Aug. 10	Aug. 11	Slight.	Slight.	0.10	6.75	1.25	5.50	.0186	.0156 .0138	.64	.0150	.0017
3136	Sept. 8	Sept. 10	Distinct, milky.	Very slight	0.05	7.35	1.10	6.25	.0246	.0258 .0152	.69	.0400	.0007
3320	Oct. 8	Oct. 9	Distinct.	Con., light green.	0.80	8.00	2.25	5.75	.0020	.0576 .0350	.64	.0150	.0002
3521	Nov. 10	Nov. 12	Decided.	Con., light colored.	0.25	7.70	1.70	6.00	.0282	.0198 .0164	.71	.0300	.0012
3653	Dec. 5	Dec. 6	Distinct, milky.	Slight.	0.05	6.70	1.70	5.00	.0064	.0120 .0114	.64	.1500	.0004
	1889.												
3821	Jan. 3	Jan. 4	Slight, milky.	Slight, earthy.	0.20	6.40	1.75	4.65	.0164	.0116 .0094	.66	.1200	.0002
3995	Feb. 8	Feb. 8	Decided, milky.	Very slight.	0.10	6.45	1.45	5.00	.0038	.0076 .0054	.67	.1100	.0005
4247	Mar. 7	Mar. 8	Decided, milky.	Slight, black.	0.05	6.50	1.85	4.65	.0012	.0080 .0058	.67	.0070	.0002
4472	Apr. 4	Apr. 6	Distinct, milky.	Very slight.	0.00	6.35	1.70	4.65	.0060	.0090 .0072	.65	.0700	.0003
4651	May 13	May 13	Distinct, milky.	Slight.	0.20	6.95	1.80	5.15	.0000	.0106 .0086	.63	.0500	.0003
Av.	....	....	....	....	0.24	6.80	1.64	5.16	.0148	.0173	.65	.0603	.0005

Hardness in May, 1888, 3.1. Odor, generally very faint or none. —— The samples were collected from a faucet in the house nearest the filter-gallery. As this faucet is sometimes supplied from the filter-gallery, sometimes from the reservoir and sometimes from both, it is possible that some of the analyses, notably numbers 528, 1421, 1593, 2426, 2618, 3320 and 4651, contain reservoir water.

Microscopical Examination.

	1888. June.	1888. July.	1888. Aug.	1888. Sept.	1888. Oct.	1888. Nov.	1888. Dec.	1889. Jan.	1889. Feb.	1889. Mar.	1889. Apr.	1889. May.
1. Blue-green Algæ, ...	0.0	0.0	0.0	pr.	64.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	3.0	0.8	0.0	0.2	10.7	1.7	0.0	pr.	pr.	0.1	0.0	2.0
3. Fungi, ...	0.7	5.0	0.0	0.7	0.0	0.0	65.0	0.5	15.0	2.5	50.0	30.0
4. Animals, ...	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0

Groups and principal genera of organisms observed: 1, Cyanophyceæ, *Clathrocystis*. 2, Palmellaceæ; Zoosporeæ, *Scenedesmus;* Desmidiaceæ; Diatomaceæ; Zygnemaceæ. 3, Schizomycetes, *Crenothrix*. 4, Protozoa; Entomostraca.

Chemical Examination of Water from Arlington Storage Reservoir.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1887.												
78	June 10	June 11	Decided.	Con., rusty.	1.00	8.05	3.85	4.20	.0094	.0788	.82	.0130	–
310	July 12	July 12	Decided.	Slight, br'n.	0.60	7.42	2.20	5.22	.0055	.0554	.66	.0070	–
731	Sept. 12	Sept. 12	Decided.	Consid'ble.	0.60	9.35	2.67	6.68	.0008	.0620	.76	.0070	–
948	Oct. 13	Oct. 14	Decided.	Con., greenish brown.	0.60	9.10	2.95	6.15	.0004	.0760 .0242	.82	.0090	–
949	Oct. 13	Oct. 14	Decided.	Con., green.	0.60	9.10	3.15	5.95	.0000	.0728	.80	.0070	–
1155	Nov. 11	Nov. 11	Decided.	Much, light colored.	0.30	8.20	2.55	5.65	.0004	.0580	.83	.0030	–
1156	Nov. 11	Nov. 11	Decided.	Con., yel'sh brown.	0.30	8.05	2.50	5.55	.0007	.0600	.83	.0040	–
1420	Dec. 15	Dec. 16	Distinct, green.	Very slight.	0.65	8.40	2.80	5.60	.0028	.0410 .0284	.85	.0200	–
	1888.												
1592	Jan. 14	Jan. 14	Slight.	Slight, br'n.	0.70	7.35	2.50	4.85	.0004	.0345	.69	.0650	.0001
1774	Feb. 8	Feb. 8	Slight.	H'y, earthy and floc'nt.	0.55	8.20	2.60	5.60	.0091	.0320	.75	.0500	.0002
1961	Mar. 7	Mar. 7	Distinct.	Very slight.	0.50	5.85	1.90	3.95	.0003	.0269	.53	.0350	.0001
2425	May 14	May 15	Decided, green.	Slight, green.	1.10	6.50	2.60	3.90	.0000	.0438 .0248	.52	.0060	.0007
2617	June 15	June 16	Decided.	Consid'ble, green.	0.80	6.30	1.95	4.35	.0000	.0460 .0256	.60	.0020	.0000
2914	Aug. 10	Aug. 11	Distinct.	Consid'ble, green.	0.30	6.80	2.00	4.80	.0000	.0490 .0274	.75	.0000	.0001
3137	Sept. 8	Sept. 10	Distinct.	Consid'ble, green.	0.20	6.65	2.30	4.35	.0016	.0528 .0288	.69	.0020	.0002
3319	Oct. 8	Oct. 9	Distinct.	Con., earthy and green.	2.30	10.30	3.55	6.75	.0020	.0500 .0446	.60	.0450	.0003
3520	Nov. 10	Nov. 12	Distinct.	Heavy, reddish brown	1.20	7.50	2.40	5.10	.0042	.0496 .0318	.70	.0200	.0004
3652	Dec. 5	Dec. 6	Distinct.	Slight.	0.80	6.30	2.60	3.70	.0004	.0378 .0280	.61	.0500	.0002
	1889.												
3820	Jan. 3	Jan. 4	Slight.	Slight.	0.60	5.65	1.60	4.05	.0006	.0290 .0202	.55	.0600	.0004
3994	Feb. 8	Feb. 8	Slight.	Very slight.	0.33	6.20	1.70	4.50	.0024	.0194 .0174	.69	.0630	.0002
4246	Mar. 7	Mar. 8	Slight, milky.	Consid'ble, fibrous.	1.20	6.60	2.55	4.05	.0080	.0370 .0292	.52	.0400	.0003
4471	Apr. 4	Apr. 6	Very slight.	Considerable.	0.90	6.95	2.50	4.45	.0052	.0308 .0270	.59	.0550	.0004
4650	May 13	May 13	Decided.	H'vy, light green.	0.55	6.25	1.95	4.30	.0012	.0508 .0252	.63	.0020	.0000
Av.	....	....	....	....	0.73	7.96	2.69	5.27	.0024	.0475	.69	.0246	.0002

Hardness in May, 1888, 2.3. Odor, faintly vegetable and grassy; seldom mouldy. —— The samples were collected from the reservoir near the gate-house, with the exception of Nos. 1774 and 1961, which were collected from a faucet in the house nearest the reservoir while water was being drawn from the reservoir only; and No. 2735, which was collected from a faucet in the village, at a time when the entire supply of the town was being drawn from the reservoir.

Microscopical Examination.

	1888. June.	Aug.	Sept.	Oct.	Nov.	Dec.	1889. Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ,	0.0	pr.	0.8	pr.	0.0	pr.	pr.	0.0	0.0	0.0	0.0
2. Other Algæ,	191.6	69.5	19.9	5.7	37.2	3.6	4.0	1.2	0.7	1.0	431.4
3. Fungi,	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animals,	pr.	6.2	1.1	0.2	1.6	0.4	7.1	4.7	0.0	0.0	0.6

Groups and principal genera of organisms observed: 1, Cyanophyceæ, *Clathrocystis*. 2, Palmellaceæ, *Chlorococcus*; Zoosporeæ, *Pediastrum*, *Scenedesmus*; Desmidiaceæ, *Cosmarium*, *Staurastrum*; Diatomaceæ, *Melosira*, *Synedra*; Zygnemaceæ. 4, Protozoa, *Dinobryon*; Entomostraca.

Chemical Examination of Water from Brook above Arlington Storage Reservoir.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Sediment.	Color.	Residue on Evaporation. Total.	Loss on Ignition.	Fixed.	Ammonia. Free.	Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrites.
2731	1888. July 6	1888. July 7	Very slight.	Slight.	0.15	8.05	2.20	5.85	.0012	.0122 .0096	.81	.1400	.0006

Odor, none. —— The sample was collected from the brook about 800 feet above the storage reservoir.

Water Supply of Arlington. — Middlesex Aqueduct Company.

This is a small water supply, introduced in 1799, and at present supplying about 34 families. The source of supply is a spring. Water is distributed by gravity, through cement-lined iron pipes.

Chemical Examination of Water from Spring, Middlesex Aqueduct Company.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Sediment.	Color.	Residue on Evaporation. Total.	Loss on Ignition.	Fixed.	Ammonia. Free.	Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrites.
786	1887. Sept. 15	1887. Sept. 16	None.	Very slight.	0.0	10.70	–	–	.0000	.0022	.66	.1950	–
1422	Dec. 14	Dec. 16	None.	Very slight	0.2	9.50	–	–	.0000	.0087	.68	.2400	–
2411	1888. May 14	1888. May 14	None.	Consid'ble, brown.	0.0	9.00	–	–	.0000	.0032	.50	.1250	.0000
Av.	....	....	....	....	–	9.73	–	–	.0000	.0047	.61	.1867	–

Hardness in May, 4.8. —— Odor, very faint or none. —— The samples were collected from a faucet in the village.

Microscopical Examination.

May, 1888. An insignificant number of algæ present. Fungi present. Groups and principal genera of organisms observed: 2, Zoosporeæ; Diatomaceæ. 3, Schizomycetes, *Crenothrix*.

Chemical Examination of Water from Spy Pond, Arlington.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.		Nitrates.	Nitrites.
	1888.												
3317	Oct. 5	Oct. 6	Distinct.	Slight, green.	0.00	14.80	2.05	12.75	.0242	.0418 .0334	2.57	.0500	.0048
3664	Dec. 6	Dec. 7	Distinct.	Slight.	0.05	15.55	3.25	12.30	.0768	.0352 .0280	2.21	.1300	.0043
	1889.												
4172	Feb. 28	Mar. 1	Distinct.	Very slight.	0.05	16.75	3.05	13.70	.0066	.0380 .0290	2.16	.1500	.0012
Av.	....	....	....	....	0.03	15.70	2.78	12.92	.0359	.0383 .0301	2.31	.1100	.0037

Odor, faintly earthy or mouldy.——The samples were collected from the pond. No. 3317 was collected about twenty feet from shore at Addison Gage & Co.'s ice-house at upper end of pond. No. 3664 was collected from the float at the Arlington Boat Club house.

Chemical Examination of Water from Little Spy Pond, Arlington.

[Parts per 100,000]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on ignition.	Fixed.	Free.	Albu-minoid.		Nitrates.	Nitrites.
	1888.												
3665	Dec. 6	Dec. 7	Decided.	Consid'ble, yellow.	0.2	12.95	3.50	9.45	.0000	.0416 .0260	1.49	.2600	.0019
	1889.												
4173	Feb. 28	Mar. 1	Decided, green.	Slight.	0.2	16.55	3.15	13.40	.0058	.0390 .0262	1.70	.1750	.0020

Odor, none.——The samples were collected from the pond near the ice-houses. Water was very high in the pond at the time of collecting sample No. 3665.

Water Supply of Ashburnham. — Naukeag Water Company.

Description of Works. — Population in 1885, 2,058. Works are owned by the Naukeag Water Company. Water was introduced in 1870. About 30 families were supplied in 1887. The source of supply is a small storage reservoir, formed by a dam 75 feet long and 15 feet high, located on the side of a large hill. The bottom of the reservoir is of ledge and clay; all the turf and loam were removed from the bottom of the reservoir at the time of its con-

struction. The drainage area is used mostly for pasturage, and is not large. During the wet portions of the year a small stream runs into the reservoir, while in dry times the surface flow ceases and all water entering the reservoir comes from springs. Distributing mains are of wrought iron, lined with cement. Service pipes are of lead.

Chemical Examination of Water from the Ashburnham Storage Reservoir.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1887.												
194	June 24	June 25	Very slight.	None.	0.00	3.05	0.57	2.48	.0000	.0081	.15	.0130	-
413	July 26	July 28	Very slight.	None.	0.15	2.52	0.25	2.27	.0002	.0055	.14	.0190	-
618	Aug. 25	Aug 27	Very slight.	None.	0.00	2.52	0.50	2.02	.0010	.0060	.08	.0160	-
848	Sept. 23	Sept. 24	None.	Considerable.	0.00	2.95	0.70	2.25	.0000	.0087	.15	.0210	-
1480	Dec. 22	Dec. 23	None.	Considerable.	0.00	2.40	0.40	2.00	.0012	.0031	.15	.0330	.0002
	1888.												
1681	Jan. 24	Jan. 25	None.	None.	0.00	2.45	0.35	2.10	.0000	.0018	.13	.0400	.0000
2116	Mar. 27	Mar. 28	Slight.	Considerable, brown.	0.00	2.35	0.60	1.75	.0000	.0050	.12	.0200	.0001
2529	May 28	May 29	Slight.	Slight.	0.00	1.95	0.25	1.70	.0000	.0074	.12	.0080	.0001
3038	Aug. 24	Aug. 25	Distinct.	Con., light green.	0.00	2.95	0.70	2.25	.0000	.0236 .0072	.16	.0020	.0000
Av.	....	....	....	....	-	2.52	0.45	2.07	.0003	.0077	.13	.0191	.0001

Hardness in May, 1888, 1.1. Odor, very faint or none. —— The samples were collected from a faucet in the village. There were heavy rains just previous to July 26, 1887.

Microscopical Examination.

	1888.		
	Mar.	May.	Aug.
1. Blue-green Algæ, ...	0.0	0.0	0.0
2. Other Algæ, ...	1.4	1.2	5.3
3. Fungi, ...	0.0	0.0	0.0
4. Animal Forms, ...	pr.	0.0	pr.

Groups and principal genera of organisms observed: 2, Palmellaceæ, *Chlorococcus;* Zoosporeæ; Desmidiaceæ; Diatomaceæ. 4, Protozoa.

Chemical Examination of Water from Upper Naukeag Pond in Ashburnham.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
-	Mar. 20	Mar. 22	Very slight.	Very slight, white.	0.10	2.40	0.70	1.70	.0004	.0136	.08	.0050	.0000
2358	May 4	May 5	Slight.	Slight.	0.20	1.85	0.65	1.20	.0000	.0142	.12	.0080	.0001
2579	June 8	June 9	Very slight.	Considerable, white.	0.10	1.75	0.60	1.15	.0000	.0160 .0098	.09	.0050	.0000
3005	Aug. 21	Aug. 22	Slight.	Very slight.	0.10	2.05	0.45	1.60	.0002	.0140 .0132	.06	.0000	.0002
	1889.												
4506	Apr. 12	Apr. 13	Very slight.	Slight.	0.05	1.95	0.85	1.10	.0000	.0196 .0134	.08	.0020	.0000
Av.	....	....	....	....	0.11	2.12	0.67	1.45	.0001	.0155	.08	.0040	.0001

Hardness in May, 1888, 0.3.—— The samples were collected from the pond near the outlet at a depth of about 6 inches beneath the surface. All the samples of water examined from this pond have had a peculiar and distinctly disagreeable odor.

Microscopical Examination.

	1888. May.	1888. June.	1888. Aug.	1889. April.
1. Blue-green Algæ,	0.0	pr.	0.0	0.0
2. Other Algæ,	0.2	0.5	0.2	0.2
3. Fungi,	0.0	0.0	0.0	0.0
4. Animal Forms,	pr.	pr.	1.1	0.8

Groups and principal genera of organisms observed: 1, Cyanophyceæ. 2, Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ; Zygnemaceæ. 4, Protozoa; Rotifera; Entomostraca.

WATER SUPPLY OF ATHOL. — ATHOL WATER COMPANY.

Description of Works. — Population in 1885, 4,758. Works are owned by the Athol Water Company. Water was introduced in 1875. There were about 450 service taps in December, 1887. There are two sources of supply. One is a small brook in Phillipston, where a storage reservoir, having an area of about 20 acres, has been constructed. This reservoir is shallow; its maximum depth is about 11 feet, and its average depth much less. The quality of the

water in this reservoir being unsatisfactory, a small reservoir, holding about a day's supply, was built just above it, and the main pipe was extended to this reservoir, so as to supply the town from this source when the quantity of water is sufficient. These reservoirs are designated as the large and small Phillipston reservoirs.

The second source of supply is Buckman Brook, in Athol; storage being furnished by an old mill-pond, known as Newton's Pond, or the Buckman Brook Reservoir. The area of this reservoir is about 8 acres, and its average depth from 12 to 15 feet. The upper village at Athol is supplied by gravity directly from the Phillipston reservoirs; but as this reservoir is about 500 feet above the lower village, and a direct supply would give too great a pressure, it is diminished by turning the water into two distributing reservoirs, known as the Pleasant Street and Summer Street distributing reservoirs. Both of these reservoirs are at the same level, and receive water from the source in Phillipston; but only the latter receives water from Newton's Pond, and the amount received from this source is limited by the small capacity of the connecting pipe. The Pleasant Street distributing reservoir is rectangular in shape, and its depth is about 12 feet when filled to the top of the bank. The Summer Street distributing reservoir is irregular in shape, with a maximum depth of 15 feet. Distributing mains are of cast iron, and service pipes are of wrought iron and lead. A mechanical filter has recently been connected with the main pipe from the Phillipston reservoir.

Chemical Examination of Water from Buckman Brook Reservoir, Athol.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1887.												
950	Oct. 12	Oct. 14	Very slight.	Slight.	0.50	3.35	1.10	2.25	.0004	.0152	.13	.0050	–
1148	Nov. 9	Nov. 11	Slight.	Very slight.	0.30	3.30	1.10	2.20	.0000	.0139	.15	.0020	–
1406	Dec. 13	Dec. 15	Distinct, milky.	Considerable.	0.25	3.95	1.15	2.80	.0416	.0124 .0100	.15	.0180	–
Av.	....	....	....	....	0.35	3.53	1.12	2.41	.0140	.0138	.14	.0083	–

Odor, very faintly vegetable. —— The samples were collected from the reservoir.

Chemical Examination of Water from Small Reservoir in Phillipston.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.		Nitrates.	Nitrites.
	1887.												
321	July 11	July 13	Very slight.	Slight.	0.70	4.00	1.35	2.65	.0012	.0120	.10	.0100	–
531	Aug. 11	Aug. 12	Very slight.	Slight.	1.50	4.62	2.07	2.55	.0018	.0334	.11	.0030	–
742	Sept. 12	Sept. 13	Slight.	Very slight.	1.20	3.97	1.62	2.35	.0007	.0167	.08	.0030	–
951	Oct. 12	Oct. 14	Very slight.	Very slight.	1.40	4.65	2.05	2.60	.0000	.0208	.23	.0070	–
1149	Nov. 9	Nov. 11	Very slight.	Slight.	0.70	4.00	1.25	2.75	.0000	.0118	.14	.0050	–
1405	Dec. 13	Dec. 15	Very slight.	Very slight.	1.60	4.25	1.95	2.30	.0012	.0216 .0202	.15	.0080	–
	1888.												
1818	Feb. 13	Feb. 14	Very slight.	Slight.	0.70	3.20	1.35	1.85	.0012	.0146	.13	.0090	.0000
1986	Mar. 8	Mar. 10	Very slight.	Slight.	0.80	3.15	1.10	2.05	.0007	.0099	.08	.0080	.0000
Av.	....	....	....	....	1.08	3.98	1.59	2.39	.0009	.0176	.13	.0066	–

Odor, very faintly vegetable.——The samples were collected from the upper or small reservoir at Phillipston. This reservoir is located just above the large Phillipston Reservoir.

Chemical Examination of Water from Large Reservoir in Phillipston.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.		Nitrates.	Nitrites.
	1887.												
70	June 9	June 11	Distinct.	Much, rusty.	1.30	4.42	2.17	2.25	.0027	.0502	.14	.0070	–
1404	Dec. 13	Dec. 15	Distinct.	Slight, white.	1.20	4.05	1.60	2.45	.0028	.0218 .0198	.17	.0080	–
1407	Dec. 13	Dec. 15	Very slight.	Very slight.	0.70	3.60	1.45	2.15	.0010	.0198	.15	.0020	–
	1888.												
1570	Jan. 10	Jan. 11	Very slight.	Very slight.	1.00	3.50	1.20	2.30	.0007	.0167	.09	.0180	.0000
1571	Jan. 10	Jan. 11	Very slight.	Very slight.	0.90	3.55	1.40	2.15	.0047	.0158	.09	.0200	.0000
1817	Feb. 13	Feb. 14	Very slight.	Slight.	0.60	3.20	1.20	2.00	.0018	.0166	.14	.0100	.0000
1987	Mar. 8	Mar. 10	Very slight.	Very slight.	0.80	2.95	1.10	1.85	.0005	.0138	.10	.0100	.0000
Av.	....	....	....	....	0.93	3.61	1.45	2.16	.0020	.0221	.13	.0107	.0000

Odor, very faintly vegetable.——The samples were collected from the large Phillipston reservoir, with the exception of Nos. 1407 and 1571, which were collected from streams of water which had percolated or filtered through the dam.

Chemical Examination of Water from a Faucet in Office of the Athol Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
69	June 9	June 11	Very slight.	None.	0.80	3.15	1.95	1.20	.0024	.0182	.14	.0020	–
322	July 11	July 13	Slight.	Very slight.	1.00	4.45	1.85	2.60	.0052	.0286	.06	.0130	–
532	Aug. 11	Aug. 12	Very slight.	Very slight.	1.10	4.55	1.97	2.58	.0011	.0278	.10	.0070	–
743	Sept. 12	Sept. 13	Slight.	Very slight.	1.00	3.60	1.27	2.33	.0003	.0195	.09	.0050	–
Av.	....	....	....	....	0.97	3.94	1.76	2.18	.0023	.0235	.10	.0068	–

Odor, very faintly vegetable.——This water is either wholly from the Phillipston Reservoirs, or a mixture of water from the Phillipston and Buckman Brook Reservoirs.

Water Supply of Attleborough Fire District, Attleborough.

Description of Works. — Population of Attleborough and North Attleborough in 1885, 13,175. North Attleborough was incorporated as a separate town in 1887. The population of the Attleborough Fire District at that time was estimated to be about 5,000 people. Works are owned by the Fire District. Water was introduced in 1873. About 877 families were supplied in 1887. The source of supply is a well and filter-gallery, with tubular wells in both, located on the right bank of Ten Mile River, just above the central part of the town. The well is 13 feet in diameter, and its bottom is about 5 or 6 feet below the bottom of the river. A filter-gallery was constructed in 1882, running for a short distance along the bank of the river and connecting with the well. The gallery is built of brick, with tight sides and open bottom, and is about 3 feet in width and height. There are three tubular wells in the bottom of the large well, which are sunk to a depth of about 40 feet below the bottom of the river and 34 feet below the bottom of the well. One of these wells is 3 inches in diameter, and the other two are each $1\frac{1}{4}$ inches in diameter. In the bottom of the filter-gallery are five tubular wells, each 2 inches in diameter. There is also a direct connection with the Ten Mile River, and whenever a fire occurs, or a trial of the fire apparatus is made, the well and tank are shut off and the direct connection with the river is used, thus filling the pipes with river water. Pumps force the water from the well to a tank, 60 feet in height and 30 feet in diameter, built of iron, lined with cement and brick. Around the tank is built a brick structure with a roof. About one-half of the distributing mains are of wrought iron, lined

with cement; the remainder are of cast iron. Service pipes are of wrought iron, lined with cement; extensions are being made with galvanized iron. There is quite a large population on a table-land, back of the well, and there is a large population along the Ten Mile River, above Attleborough.

Chemical Examination of Water from Well, Attleborough Water Works.
[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.		Nitrates.	Nitrites.
	1887.												
132	June 17	June 18	None.	Slight.	0.05	9.77	–	–	.0008	.0020	1.07	.0910	–
358	July 18	July 19	Very slight.	Considerable, earthy.	0.00	9.00	–	–	.0025	.0053	1.03	.1040	–
551	Aug. 16	Aug. 16	None.	Slight.	0.00	8.50	–	–	.0026	.0030	1.02	.0580	–
776	Sept. 15	Sept. 16	Slight, opales'nt.	None.	0.00	11.35	–	–	.0008	.0030	1.19	.1300	–
1017	Oct. 24	Oct. 25	Very slight.	Slight.	0.00	9.25	–	–	.0010	.0019	1.18	.0600	–
1359	Dec. 8	Dec. 9	Very slight, milky.	Considerable, earthy.	0.00	10.65	–	–	.0020	.0026	1.19	.1300	–
	1888.												
1786	Feb. 9	Feb. 10	Very slight.	Very slight.	0.00	10.05	–	–	.0020	.0037	1.13	.0900	.0016
2207	Apr. 13	Apr. 14	Very slight.	Heavy, earthy.	0.05	9.95	–	–	.0000	.0037	1.02	.0600	.0012
2592	June 12	June 13	None.	Very slight.	0.05	8.75	–	–	.0010	.0030	1.02	.0900	.0005
2723	July 6	July 6	None.	Slight, earthy.	0.05	7.40	–	–	.0018	.0048 .0046	0.96	.0650	.0004
2724	July 6	July 6	None.	Slight, earthy.	0.05	9.10	–	–	.0006	.0046 .0044	1.10	.0750	.0014
3095	Sept. 6	Sept. 7	None.	Considerable, black.	0.00	9.55	–	–	.0032	.0084 .0048	1.10	.0950	.0013
3446	Oct. 25	Oct. 26	None.	Slight.	0.00	9.15	–	–	0014	.0018 .0018	1.05	.0650	.0007
3625	Nov. 30	Dec. 1	None.	None.	0.00	8.65 8.60	–	–	.0016	.0034 .0022	0.94	.0900	.0008
3763	Dec. 20	Dec. 20	Distinct, milky.	Slight.	0.00	11.20	–	–	.0034	.0016	1.05	.1500	.0009
	1889.												
4297	Mar. 14	Mar. 14	Very slight, milky.	None.	0.05	10.20	–	–	.0024	.0014	1.12	.1550	.0009
4493	Apr. 10	Apr. 11	Slight.	None.	0.00	9.75	–	–	.0024	.0023	1.12	.1500	.0011
4684	May 17	May 17	None.	Slight, sandy.	0.00	8.55	–	–	.0014	.0030	1.01	.0750	.0010
4745	May 27	May 28	Very slight, milky.	None.	0.00	10.90	–	–	.0002	.0016	1.21	.1800	.0030
Av.	....	....	....	....	0.02	9.13	–	–	.0016	.0032	1.08	.1007	.0011

Hardness in December, 1887, 4.1. Odor, none. —— The samples were collected from the well with the following exceptions: No. 776 was collected from a drinking fountain; Nos. 2724 and 4745 were collected from a tubular well sunk in the bottom of the collecting well.

Mieroseopical Examination.

	1888.							1889.			
	June.	July.	July.	Sept.	Oct.	Nov.	Dec.	Mar.	Apr.	May.	May.
1. Blue-green Algæ, . .	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, . . .	0.0	0.0	0.1	0.0	0.0	pr.	0.0	0.0	pr.	0.0	0.0
3. Fungi, ...	6.0	7.5	20.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, . . .	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Groups and principal genera of organisms observed: 3, Schizomycetes, *Crenothrix*.

Chemical Examination of Water from Ten Mile River at Attleborough.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
133	June 17	June 18	Very slight.	None.	0.60	5.02	1.80	3.22	.0004	.0180	.36	.0130	–
357	July 18	July 19	Very slight.	Very slight.	0.80	4.05	1.60	2.45	.0038	.0297	.31	.0030	–
550	Aug. 16	Aug. 16	Slight.	None.	0.60	4.92	1.35	3.57	.0004	.0188	.41	.0030	–
775	Sept. 15	Sept. 16	Distinct.	Considerable.	0.30	4.65	1.40	3.25	.0016	.0234	.45	.0030	–
1016	Oct. 24	Oct. 25	Distinct.	Slight, earthy.	1.00	5.95	2.10	3.85	.0006	.0273	.57	.0100	–
1357	Dec. 8	Dec. 9	Distinct.	Slight.	0.35	5.10	1.45	3.65	.0046	.0164	.58	.0280	–
	1888.												
1785	Feb. 9	Feb. 10	Slight.	Slight.	0.50	4.75	1.65	3.10	.0131	.0192	.38	.0280	.0002
2208	Apr. 13	Apr. 14	Very slight.	Very slight.	1.10	4.00	1.30	2.70	.0000	.0227	.31	.0120	.0002
2591	June 12	June 13	Very slight.	Slight, white.	0.50	4.30	1.35	2.95	.0004	.0246 .0208	.25	.0100	.0002
2722	July 6	July 6	Very slight.	Very slight.	1.50	4.85	2.35	2.50	.0002	.0280	.34	.0080	.0002
3094	Sept. 6	Sept. 7	Very slight.	Slight.	0.35	4.80	1.65	3.15	.0024	.0262 .0238	.40	.0030	.0000
3445	Oct. 25	Oct. 26	Very slight.	Very slight.	0.70	4.50	1.65	2.85	.0000	.0214 .0172	.42	.0180	.0005
3624	Nov. 30	Dec. 1	Slight.	Considerable, earthy.	0.45	3.60	1.50	2.10	.0006	.0154 .0154	.34	.0200	.0002
3762	Dec. 20	Dec. 20	Distinct.	Sl't, earthy and floc't	0.50	3.45	1.10	2.35	.0024	.0154 .0130	.30	.0180	.0004
	1889.												
4022	Feb. 15	Feb. 15	Slight, milky.	Slight.	0.30	3.75	1.20	2.55	.0070	.0080 .0066	.40	.0250	.0003
Av.	....	....	....	....	0.64	4.81 4.18	1.58 1.54	3.23 2.64	.0025	.0210 .0161	.39	.0135	.0002

Hardness in December 1887, 2.0. Odor, generally vegetable, sometimes mouldy.——The samples were collected from the river opposite the collecting well of the Attleborough Fire District. At the time No. 3624 was collected the river was very high on account of heavy rains.

Microscopical Examination.

	1888.						1889.
	June.	July.	Sept.	Oct.	Nov.	Dec.	Feb.
1. Blue-green Algæ,	0.0	0.0	0.0	0.0	pr.	0.0	0.0
2. Other Algæ,	8.4	1.0	1.1	8.1	2.1	0.0	1.5
3. Fungi,	pr.	2.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms,	0.4	pr.	0.2	0.0	0.0	0.0	1.2

Groups and principal genera of organisms observed: 1, Cyanophyceæ. 2, Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Asterionella*, *Synedra*, *Tabellaria;* Zygnemaceæ. 3, Schizomycetes, *Crenothrix*. 4, Protozoa, *Dinobryon*.

Proposed Water Supply of Avon.

Chemical Examination of Water from Porter's Spring.

[Parts per 100,000.]

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.
	1889.												
4300	Mar. 14	Mar. 15	None.	None.	0.0	2.85	–	–	.0000	.0006	.26	.0210	.0000

Hardness, 1.3. Odor, none.—— The sample was collected from Porter's Spring.

Microscopical Examination.

March, 1889. 1, Blue-green algæ, 0.0. 2, Other algæ, pr. Groups and principal genera of organisms observed: 2, Diatomaceæ.

Water Supply of Ayer.

Description of Works. — Population in 1885, 2,190. Works are owned by the town. Water was introduced Dec. 15, 1887. The daily average consumption in 1888 was about 40,000 gallons. The source of supply is a well near the outlet of a large mill-pond. The well is 25.7 feet in depth, 26 feet in diameter at the top, and 25 feet at the bottom. The bottom is in rock, which is met with at 18.7 feet below the surface. There is a direct connection with the brook flowing from the mill-pond. Water is pumped from the well by water-power to an open distributing reservoir, having a capacity of 1,040,000 gallons. This reservoir is oval in shape, and is 13 feet in depth. The bottom is of concrete, and the slopes are paved. Distributing mains are of cast iron. Service pipes are of lead.

Chemical Examination of Water from Well, Ayer Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
209	June 28	June 28	None.	None.	0.0	4.82	–	–	.0000	.0004	.32	.0390	–
	1888.												
1536	Jan. 4	Jan. 5	Very slight.	None.	0.0	5.35	–	–	.0000	.0014	.37	.0700	.0002
1653	Jan. 20	Jan. 21	None.	None.	0.0	5.65	–	–	.0000	.0010	.32	.0550	.0003
1788	Feb. 9	Feb. 10	None.	None.	0.0	6.35	–	–	.0004	.0058	.30	.0380	.0000
1885	Feb. 22	Feb. 23	None.	None.	0.0	5.35	–	–	.0000	.0010	.36	.0800	.0000
2060	Mar. 19	Mar. 21	Very slight, milky.	None.	0.0	5.15	–	–	.0000	.0006	.33	.0450	.0000
2231	Apr. 16	Apr. 17	Slight, milky.	Very slight.	0.0	4.60	–	–	.0000	.0006	.34	.0700	.0000
2423	May 14	May 15	None.	None.	0.0	5.15	–	–	.0000	.0006	.30	.0450	.0000
2687	June 28	June 29	None.	Very slight.	0.0	5.90	–	–	.0012	.0018 .0010	.34	.0850	.0002
2807	July 19	July 20	None.	None.	0.0	5.70	–	–	.0000	.0016	.35	.0900	.0002
3013	Aug. 22	Aug. 23	None.	None.	0.0	5.60	–	–	.0004	.0022	.30	.0500	.0001
3370	Oct. 15	Oct. 16	Distinct.	Slight, earthy.	0.0	–	–	–	.0000	.0020 .0014	.26	.0450	.0000
3572	Nov. 17	Nov. 19	None.	None.	0.0	5.10	–	–	.0000	.0018	.31	.0750	.0000
3719	Dec. 14	Dec. 15	None.	None.	0.0	4.85	–	–	.0000	.0010	.34	.0700	.0003
	1889.												
3855	Jan. 15	Jan. 17	None.	Very slight.	0.0	4.80	–	–	.0000	.0020	.34	.0750	.0000
4035	Feb. 18	Feb. 18	None.	None.	0.0	4.60	–	–	.0002	.0012	.34	.0650	.0000
4331	Mar. 18	Mar. 19	Very slight.	Considerable, earthy.	0.0	4.75	–	–	.0012	.0028	.31	.0850	.0000
4529	Apr. 17	Apr. 18	None.	Slight, rusty.	0.0	4.85 4.75	–	–	.0034	.0028 .0012	.28	.0580	.0001
4665	May 15	May 15	None.	None.	0.0	5.00	–	–	.0002	.0020	.28	.0500	.0000
Av.	....	....	....	....	0.0	5.16	–	–	.0004	.0017	.32	.0626	.0001

Hardness in June, 1887, 2.1; in February, 1888, 2.6; in May, 1888, 2.2; in November, 1888, 2.6. Odor, generally none.——The samples were collected from the well, or from a faucet at the pumping station while pumping, with the exception of No. 209, which was collected from a flowing tubular well on site of present well, and No. 1536, which was collected from a faucet in the village.

Microscopical Examination.

	1888. June.	1888. July.	1888. Aug.	1888. Oct.	1888. Nov.	1888. Dec.	1889. Jan.	1889. Feb.	1889. Mar.	1889. Apr.	1889. May.
1. Blue-green Algæ, ...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	pr.
3. Fungi, ...	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, ...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Groups and principal genera of organisms observed: 2, Diatomaceæ. 3, Schizomycetes.

Chemical Examination of Water from Ayer Distributing Reservoir.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid		Nitrates.	Nitrites.
	1888.												
1654	Jan. 20	Jan. 21	None.	None.	0.00	5.95	–	–	.0000	.0024	.36	.0800	.0003
1789	Feb. 9	Feb. 10	Very slight, milky.	None.	0.00	6.55	–	–	.0008	.0068	.41	.0700	.0003
1886	Feb. 22	Feb. 23	Slight, milky.	None.	0.00	4.25	–	–	.0014	.0084	.27	.0500	.0001
2059	Mar. 19	Mar. 21	Very slight, milky.	None.	0.00	5.50	–	–	.0000	.0024	.35	.0500	.0003
2232	Apr. 16	Apr. 17	Slight, milky.	Very slight.	0.00	4.80	–	–	.0000	.0032	.28	0600	.0005
2424	May 14	May 15	Slight.	None.	0.00	4.95	–	–	.0000	.0026	.30	.0400	.0006
2688	June 28	June 29	Distinct.	Slight, white.	0.00	6.15	–	–	.0028	.0150 .0108	.35	.0300	.0015
3571	Nov. 17	Nov. 19	Very slight.	Very slight.	0.00	5.35	–	–	.0000	.0032	.31	.0750	.0002
3718	Dec. 14	Dec. 15	Distinct.	Con., earthy and floc't.	0.00	7.20 5.60	–	–	.0000	.0070 .0028	.36	.0500	.0007
	1889.												
3856	Jan. 15	Jan. 17	Distinct.	Slight, white.	0.00	5.80	–	–	.0016	.0082 .0034	.38	.0600	.0002
4036	Feb. 18	Feb. 18	Decided.	Slight, green.	0.05	5.70 4.75	–	–	.0024	.0156 .0072	.33	.0450	.0003
4332	Mar. 18	Mar. 19	Very slight.	Slight.	0.00	5.40 4.90	–	–	.0006	.0124 .0042	.31	.0750	.0002
4530	Apr. 17	Apr. 18	Slight.	Very slight.	0.00	5.25	–	–	.0012	.0134 .0040	.32	.0250	.0007
4666	May 15	May 15	Very slight.	Slight.	0.00	5.70	–	–	.0016	.0114 .0036	.32	.0300	.0006
Av.	....	....	....	....	0.00	5.55	–	–	.0009	.0080	.33	.0529	.0005

Hardness in May, 1888, 2.5; in November, 1888, 2.6. Odor, generally none.—— The samples were collected from the reservoir. There was a depth of but two feet of water in the reservoir at the time sample No. 2688 was collected.

Microscopical Examination.

	1888.						1889.				
	Mar.	Apr.	May.	June.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ, . . .	0.0	–	–	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	0.0	–	–	51.8	0.0	pr.	pr.	2.0	2.1	6.5	13.0
3. Fungi, ...	0.0	–	–	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, ...	0.0	–	–	0.0	0.0	0.0	pr.	0.0	0.0	0.0	0.0

Groups and principal genera of organisms observed: 2, Palmellaceæ, *Protococcus;* Zoosporeæ, *Scenedesmus;* Diatomaceæ, *Fragillaria, Synedra.* 4, Protozoa.

Chemical Examination of Water from Sandy Pond in Ayer.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1887.												
208	June 28	June 28	Slight.	Very slight.	0.4	2.70	1.00	1.70	.0002	.0176	.14	.0000	–

Odor, faintly vegetable.—— The sample was collected from Sandy Pond, about 350 feet from shore and 4 to 5 feet beneath the surface.

Barnstable.

Chemical Examination of Water from Nine Mile Pond in Barnstable.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1888.												
2965	Aug. 16	Aug. 17	Very slight.	Very slight.	0.0	3.60	0.55	3.05	.0004	.0160 .0130	1.05	.0030	.0000

Odor, earthy.—— The sample was collected from the pond.

Microscopical Examination.

August, 1888.—1, Blue-green algæ, pr.; 2, Other algæ, pr.; 3, Fungi, 0.0; 4, Animal Forms, pr.

Groups and principal genera of organisms observed: 1, Cyanophyceæ. 2, Diatomaceæ. 4, Protozoa; Nematoda; Rotifera.

Water Supply of Belmont.

Description of Works.—Population in 1885, 1,639. The distributing system is owned by the town. Water is supplied by the Watertown Water Company, and was introduced in 1887. *See Watertown.*

Water Supply of Beverly.

Description of Works.—Population in 1885, 9,186. Works are owned by the town. Water was first introduced from the water works of the city of Salem in 1868–69. Independent works were built by the town in 1886, and the supply from Salem was discon-

tinued. The number of services supplied is 2,260. The source of supply is Wenham Lake, in Beverly and Wenham. Water is pumped from the lake to an open distributing reservoir, having a capacity of 3,000,000 gallons. Distributing mains are of wrought iron, lined with cement. Service pipes are of galvanized iron. For a description of the source of supply and analyses of the water, see Salem.

Water Supply of Boston.

Description of Works. — Population in 1885, 390,393. Boston is supplied from two distinct systems of works,* one, deriving its supply from the Sudbury River and Lake Cochituate, known as the Cochituate Works; and the other, from the Upper Mystic Lake, known as the Mystic Works.

Cochituate Works.

These works supply the whole of the city except the Charlestown District. The population in the district supplied in 1885 was 352,720, and the population in 1888 was estimated to be 378,600. Water is supplied from Sudbury River and from Lake Cochituate to the main distributing reservoir at Chestnut Hill by separate aqueducts.

Sudbury River Supply. — The supply is derived from a system of five storage reservoirs, four of them being artificial reservoirs located on Sudbury River or its tributaries; and one being a natural pond, known as Farm Pond, which formerly had an outlet into the river. The watershed of Sudbury River at the lowest dam is 74.656 square miles, and of Farm Pond 0.543 square miles, making the total available watershed 75.199 square miles. The watershed contains the whole or the main portion of the following towns: —

	Population in 1885.
Southborough,	2,100
Marlborough,	10,941
Westborough,	4,880
Hopkinton,	3,922
Ashland,	2,633
Total,	24,476

* In addition to these two systems there is another, owned by the Jamaica Pond Aqueduct Company, which supplies a small population. Following the usual custom, this source will be ignored in giving statistics regarding the Boston water supply, but will be described after the others.

A portion of the town of Framingham (population in 1885, 8,275) is also in the watershed. The total population on the watershed in 1885 was about 24,000, equal to a population of 319 per square mile.

The towns of Marlborough, Westborough and Hopkinton, and the village of South Framingham, have a public water supply; but none of these places were provided with a sewerage system during the time covered by this report.

The watershed contains many hills with steep slopes, used to a large extent for pasturage, but in many cases covered with a small growth of wood. The valleys, as a rule, are not steep and there are extensive areas of swampy land, generally covered with a growth of brush or trees. Except in the immediate vicinity of the towns the land is not highly cultivated.

Farm Pond is the reservoir nearest to Boston, and from it the Sudbury aqueduct, built of masonry, conveys water to the Chestnut Hill Distributing Reservoir. Provision is made, however, by means of an extension of the masonry aqueduct across Farm Pond and beyond to Dam No. 1, and by a system of iron pipes extending from this dam to the reservoirs above, for drawing water directly into the main aqueduct from Reservoirs No. 1, 2, or 3. These arrangements make it feasible to draw water through the aqueduct to Chestnut Hill Reservoir directly from Farm Pond or either of the reservoirs mentioned, as may be desirable on account of either the quality or quantity of water stored in them. The water in Reservoir No. 4 has to pass through Reservoir No. 2 on its way to the city.

The following table gives statistics relating to storage reservoirs of the Sudbury River supply: —

NAME.	Areas of Watersheds, including Water Surfaces. Exclusive of Watersheds of Reservoirs above. Square miles.	Areas of Watersheds, including Water Surfaces. Total Contributing Watershed. Square miles.	Area of Water Surface. Acres.	Storage Capacity of Reservoir. U. S. gallons.	Average Depth of Reservoir. Feet.	Maximum Depth of Reservoir. Feet.
Farm Pond,* . . .	0.543	75.199	165	167,500,000	7	20
Reservoir No. 1, . .	1.840	74.656	149	288,400,000	6	13
Reservoir No. 2, . .	39.073	45.139	133	529,800,000	12	16
Reservoir No. 3, . .	27.677	27.677	247	1,080,000,000	13	21
Reservoir No. 4, . .	6.066	6.066	170	1,416,000,000	26	46

* The area, capacity and average depth of the pond have been changed somewhat from the figures given, on account of extensive filling by the Old Colony Railroad and the city of Boston. The storage given is that contained in the upper 3.25 feet.

Farm Pond had naturally a watershed of 1.008 square miles; but as the land on the westerly side of the pond was highly cultivated, an intercepting ditch and dike were built on the shore of the pond, which cut off nearly one-half of the watershed, leaving 0.543 square miles. As the land is porous, much of the water from the area diverted still finds its way by filtration into the pond. Until July 9, 1886, all water from the storage reservoirs had to pass through Farm Pond on its way to the city, except during a few months in the latter part of 1881 and the early part of 1882. At this time, on account of a very strong "cucumber" taste which had its origin in this pond, it was drawn down and a temporary ditch was constructed in the exposed portion of the bottom to carry the water around the pond to supply the city. The bottom of Farm Pond, in the shallow portions, is generally sandy, but in the deeper portions much of it is muddy. The village of South Framingham is located on the easterly side of the pond, and a considerable portion of it, though less than one-half, drains directly or by filtration through the ground into the pond. A sewerage system for this village has recently been built, which is intended to divert from the watershed all sewage which now enters the pond. When the water from the reservoirs passes through Farm Pond, its waters assume approximately the character of that in the reservoir from which it is supplied.

Reservoir No. 1 being shallow has not been used for supplying the city, though the water is available if it should be needed.

Reservoir No. 2 was completed and filled in 1879. In the beginning the loam was not removed from the reservoir; but in 1883 and 1884 a large amount of loam and other material was excavated so as to give a minimum depth of not less than 8 feet, with steep slopes all around the reservoir, many of them paved. In addition to the excavation for the shallow flowage the loam and much of the muck were removed from the deeper portions of the reservoir. A low dam, submerged at high water, has been built across the reservoir toward its upper end, to prevent the shallow upper end from becoming bare when the water in the reservoir is drawn down. The drainage area of this reservoir contains nearly all of the towns of Westborough, Hopkinton and Ashland, having a total population of about 11,000 in 1885. It also contains a large area of swampy land, which gives the water a brownish tinge.

Reservoir No. 3 was first filled in December, 1878. Before filling it, the brush and trees growing on the area included in the reservoir were cut down and removed. It contained in the lower portion where the water is deep a large wooded swamp which was burned over after the trees had been removed. The reservoir was emptied in 1886 and improved by removing the shallow flowage so as to get not less than 10 feet depth at high water, by making steep gravel or paved slopes around the sides, and by removing all stumps and some of the mud from the lower portions of the reservoir. The drainage area of this reservoir contains the larger part of the towns of Marlborough and Southborough, with a population in 1885 of about 13,000. This reservoir, having a larger population than Reservoir No. 2, on a smaller watershed, is more affected by sewage pollution. There are fewer swamps, however, on this watershed, so that the water has less color.

Reservoir No. 4 was begun in 1882 and completed in 1885. It was full for the first time April 1, 1886. This reservoir was thoroughly cleaned of all loam, stumps and vegetable matter when first constructed, and it was deepened wherever the depth at high-water mark was less than 8 feet. The drainage area contains but few inhabitants; a portion of it is swampy.

Lake Cochituate, from which water flows to Chestnut Hill Reservoir through the Cochituate aqueduct, has an area of 801 acres when full. Its high-water mark is 13 feet 4 inches above the bottom of the Cochituate aqueduct, and the amount of water stored, above a level 4 feet above the bottom of the aqueduct, is 1,900,000,000 gallons. The larger portion of the lake is natural, but it has been raised at three different times, first in 1844 and last in 1859, a total of 7 feet, flooding to a depth of about 6 feet a large area of meadow, nearly all of it at the southerly end of the lake. Since 1887 some extensive improvements have been made on the shores of the lake bordering upon these flowed meadows. In other portions of the lake a clean shore of gravel or sand has been formed by the action of the waves. The lake occupies the bottom of a narrow valley running nearly north and south, its extreme length being about 3.5 miles and its greatest width about 1,800 feet. At two points the shores approach close to each other, and roads cross the lake dividing it into three divisions. The maximum depth in the southern division is 72 feet, in the central division 50 feet, and in the northern division 64 feet.

Lake Cochituate has within its drainage area of 18.87 square miles two large ponds known as Dug and Waushakum ponds, and portions of the towns of Natick, Framingham, Sherborn and Wayland. Dug Pond is the source of water supply for Natick, and will be described under Natick. Waushakum Pond is used as a water supply for the Reformatory Prison for Women in Sherborn, and will be referred to under Sherborn. The population of Natick in 1885 was 8,460, the larger portion of which is within the Cochituate watershed. In the town of Framingham the larger part of the village of South Framingham, with a population of about 5,000, is included in the watershed. In Wayland, the village of Cochituate, with about 1,200 inhabitants, and in Sherborn a population of about 250 persons in the Reformatory Prison for Women, together with a small population near the village of South Framingham, are included in the watershed. Some of the pollution from Natick enters the southern division of Lake Cochituate through Pegan Brook; while another portion goes into Dug Pond and only enters the lake when there is an overflow from this pond. From South Framingham, and a small population in Sherborn, pollutions enter the southern division of the lake through Beaver Dam Brook, which is the main feeder of the lake. Sewage from the Reformatory Prison for Women is filtered through land, and the effluent runs into the southerly end of Lake Cochituate through Course Brook. Pollution from Cochituate village enters the northern division of the lake from which water is taken for supplying the city or wasted over the dam when there is a surplus. It is to be noticed from the foregoing that the bulk of the pollution enters the lake at its southerly end, and, owing to the size of the lake and its separation into divisions, a long time elapses before such pollution can reach the entrance to the aqueduct. A sewerage system has been built in South Framingham, designed to pump the sewage to a point outside of the Cochituate watershed and there filter it through land, but it was not put in operation until after the period covered by this report. The watershed of Lake Cochituate is, as a rule, flat, sandy or gravelly land. In the valley of Beaver Dam Brook there are swamps and meadows of considerable extent. Just outside of the watershed of Lake Cochituate is Dudley Pond, having an area of 81 acres and a small watershed. Water can be drawn from this pond into the lake by means of a connecting pipe.

The Sudbury aqueduct, in its course from Farm Pond to Chestnut Hill Reservoir, passes through the watershed of Lake Cochituate;

and where it crosses Course Brook, provision is made for turning water from Farm Pond or the Sudbury storage reservoirs into the brook. In this way it is possible to use Lake Cochituate as a storage reservoir for Sudbury River water; but the lake has not been so used since August, 1884, so that the analyses of water from Lake Cochituate given in this report have not, probably, been appreciably affected by the addition of Sudbury River water.

Chestnut Hill Reservoir, situated about 5.5 miles from the centre of the city and within the municipal limits, is the main low-service distributing reservoir of the Cochituate Works. It receives water from both Sudbury River and Lake Cochituate. The reservoir is divided into two basins. The lower one, known as the Bradlee Basin, has an area of 85 acres, and its capacity is 550,600,000 gallons. The upper one, known as the Lawrence Basin, has an area of 38 acres, and its capacity is 180,900,000 gallons. The total area of this reservoir is 123 acres, and its total capacity is 731,500,000 gallons. The average depth of water in the Bradlee Basin is 19.8 feet and its maximum depth 32 feet. In the Lawrence Basin the average depth is 14.6 feet and the maximum depth 17 feet. Both basins are surrounded with steep paved slopes. Nearly all of the loam and muck was removed from the bottom of the Bradlee Basin, and some was removed from the Lawrence Basin.

Brookline Reservoir was, until the construction of the Chestnut Hill Reservoir, the main low-service distributing reservoir. It is still used as a distributing reservoir, and receives about the same admixture of water from Sudbury River and Lake Cochituate as the Chestnut Hill Reservoir. Its area at a level 2 feet below the top of the dam is 22.95 acres, and its capacity at this level is 119,600,000 gallons. Its greatest depth is 24 feet and its mean depth 16 feet.

The High-Service system of water works in Boston has been changed during the time covered by this report. In 1887 the water for the high service was pumped in Roxbury from one of the mains leading to the city into the Parker Hill Reservoir. After Dec. 3, 1887, water was pumped from the same place to the Fisher Hill Reservoir, the Parker Hill Reservoir being shut off from the supply until July 2, 1888. On May 8, 1888, the pumping station in Roxbury was abandoned, and the pumping is now done at the new pumping station at Chestnut Hill Reservoir, the water being pumped to Fisher Hill Reservoir.

Fisher Hill Reservoir is rectangular in shape, 500 feet long by 295 feet broad, measured at the top of the inner slope of the embankment. The bottom is nearly level, the depth at high-water mark varying from 18 to 20 feet. The bottom is formed of clay puddle. The slopes for about two-thirds of the way from the bottom are lined with concrete and above with stone paving.

Parker Hill Reservoir is nearly rectangular in shape, and the area of the water surface at high water is 1.47 acres. The slopes are paved; the bottom is nearly level, the depth varying from 19 to 21 feet when the reservoir is at high-water mark. The bottom of the reservoir is formed of clay puddle.

Mystic Works.

These works supply the Charlestown district of Boston, the cities of Chelsea and Somerville and the town of Everett. The population of these places in 1885 was as follows: —

City or Town.	Population in 1885.
Charlestown,	37,673
Chelsea,	25,709
Somerville,	29,971
Everett,	5,825
Total,	99,178

The estimated total population in 1888 was 108,000.

The water is taken from the Upper Mystic Lake by means of an aqueduct to a pumping station, and is there pumped to a distributing reservoir on College Hill in Medford, from which it flows by gravity to the towns supplied.

Upper Mystic Lake was formerly a tidal basin at the head of the Mystic River; but, owing to the small size of the river and the distance from Boston Harbor, the tidal fluctuation was small, the water remaining nearly at the level of high tide. The construction of the dam between the Upper and Lower Mystic lakes raised the former to a level 7 feet above high tide, and increased its area by flowing a large amount of flat land at the upper end. Its area at the present high-water mark is 200 acres. The storage capacity above a level 4.2 feet above the bottom of the aqueduct is 380,000,000 gallons. The lake is deep in all portions except the flowed area at the upper end. The maximum depth is 87 feet. The lake receives its supply from a watershed of 27.75 square miles. This watershed

contains the city of Woburn, the town of Winchester and the populated portion of the town of Stoneham. The population of these municipalities in 1885 was as follows: —

Woburn,	11,750
Winchester,	4,390
Stoneham,	5,659
Total,	21,799

In addition to these towns a portion of the town of Reading is included in the watershed, and contains a population as large as that contained in the portion of the town of Stoneham not in the watershed; so that the total population above given represents very nearly the total population on the watershed. On this basis the population was 785 per square mile in 1885. The population at the present time (1889) is estimated to be 850 per square mile. All of the three towns in the watershed are provided with public water supplies. The amount of water supplied to Woburn is about 800,000 gallons per day, and the amount used in Winchester and Stoneham is estimated at 500,000 gallons per day; making a total of 1,300,000 gallons per day of water, which is nearly all polluted by the various uses to which it is put. Of this amount fully 1,000,000 gallons find their way into the streams, either directly or by overflow or filtration, from cesspools. The remainder of the polluted water, chiefly that used in tanneries, is diverted from the supply by a sewer which has been in use since 1878. The Mystic watershed was carefully examined in 1874 by engineers of the city of Boston, who found that the watershed then contained 81 factories employing about 3,500 hands. A large proportion of these were tanneries or curriers' shops, from most of which the sewage is carried away by the sewer above referred to. There are several tanneries, however, and one very large glue factory, which are far from the sewer and turn their refuse into the streams, either in a crude state or after the removal of some of the offensive matters.

The larger part of the watershed is drained by the Abbajona River, which enters the lake at its northerly end. About a mile above the lake the river is joined by the Horn Pond branch, coming from the westerly side, and nearly as large as the river. At and near the junction of these streams are several large ponds connected with each other, with extensive areas which are very shallow. On the Abbajona River above the junction there are several large mill-

ponds, and on the westerly branch is situated Horn Pond. This pond is described, and analyses of its water are given, under Woburn. The large storage reservoir of the Winchester water works is situated in the easterly part of the watershed (see Winchester). The Mystic drainage area is generally hilly and contains few swamps.

College Hill Reservoir is 4.5 acres in area, and 26 feet deep at high water. It is divided into two parts by a partition embankment, the top of which is 5 feet below high-water mark. The water-tight lining of the bottom of the reservoir is formed of a layer of puddle covered with 3 inches of concrete. The sides, which have a slope of $1\frac{1}{2}$ to 1, are formed of a layer of puddle covered with brick work 8 inches in thickness up to a line $4\frac{1}{2}$ feet below high water, above which is a facing of granite.

Jamaica Pond Supply.

Jamaica Pond was the principal source of water supply for the city of Boston between the years 1796 and 1848, and has continued to be used as a source of water supply to the present time. The works are at present owned by the Jamaica Pond Aqueduct Company, and water is supplied to a portion of the Roxbury district of Boston. The pond is situated within the limits of the city. Its area at high water is about 69 acres, and its maximum depth 57 feet. It is nowhere shallow, and the average depth is about 27 feet.

The drainage area of 467 acres (including the area of the pond) is inhabited by about 600 people — equal to 822 to the square mile. The main portion of the drainage area is occupied by the large estates of wealthy residents. Near the pond on the southeasterly side the population is more dense. This population, however, consisting of about 150 people, is in a district provided with sewers which divert the sewage from the pond. On the westerly side of the pond there is a small cluster of houses, occupied by about 100 people, in a district not provided with sewers. There are no swamps on the drainage area. The Jamaica Pond Aqueduct Company supplies water to consumers by pumping to a small standpipe. Distributing mains are of cast iron. Service pipes are of lead. There were about 1,500 water takers in 1887. When the supply of water from the pond is insufficient, water is purchased from the Cochituate Works of the city of Boston.

SUDBURY RIVER SUPPLY. — *Chemical Examination of Water from Reservoir No. 4, in Ashland, collected one foot beneath the surface.*

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
15	May 31	June 1	Slight.	None.	1.00	3.63	1.95	1.68	.0011	.0231	–	–	–
235	June 30	July 1	Very slight.	None.	0.95	4.07	1.35	2.72	.0011	.0266	.28	.0065	–
460	Aug. 1	Aug. 2	Very slight.	None.	0.80	3.92	1.95	1.97	.0005	.0229	.24	.0030	–
651	Aug. 31	Sept. 1	Very slight.	None.	0.70	3.75	1.35	2.40	.0000	.0243	.24	.0000	–
863	Oct. 3	Oct. 4	Slight.	Very slight.	0.55	3.52	1.57	1.95	.0003	.0243	.24	.0030	–
1072	Oct. 31	Nov. 1	Slight.	Slight.	0.70	3.50	1.10	2.40	.0006	.0262	.26	.0020	–
1283	Nov. 30	Dec. 1	Slight.	Slight.	0.50	3.60	1.30	2.30	.0000	.0251	.26	.0050	–
	1888.												
1513	Jan. 2	Jan. 3	Slight.	Slight.	0.70	4.00	1.50	2.50	.0012	.0235	.22	.0060	.0000
1716	Feb. 1	Feb. 1	Slight.	Slight.	0.70	4.50	2.00	2.50	.0015	.0297	.20	.0100	.0000
1926	Mar. 1	Mar. 2	Slight.	Very slight.	0.70	3.85	1.60	2.25	.0003	.0323	.23	.0120	.0000
2136	Apr. 2	Apr. 3	Slight.	None.	0.45	3.18	0.95	2.23	.0018	.0248	.18	.0030	.0001
2330	May 1	May 2	Slight.	Very slight.	0.70	3.50	1.65	1.85	.0002	.0232	.21	.0050	.0002
2546	June 4	June 5	Distinct.	Considerable.	1.00	**3.55**	**1.60**	**1.95**	.0004	.0328 **.0226**	.22	.0060	.0001
2701	July 2	July 3	Slight.	Slight.	0.70	**3.80**	**1.80**	**2.00**	.0000	.0268 **.0234**	.25	.0050	.0001
2863	Aug. 1	Aug. 2	Slight.	Very slight.	0.90	**3.65**	**1.80**	**1.85**	.0002	.0286 **.0254**	.26	.0000	.0003
3042	Sept. 4	Sept. 5	Slight.	Slight.	0.50	**4.00**	**1.85**	**2.15**	.0000	.0256 **.0212**	.19	.0030	.0001
3289	Oct. 1	Oct. 2	Slight.	Slight, green.	0.70	**3.85**	**1.60**	**2.25**	.0008	.0286 **.0232**	.20	.0020	.0001
3487	Oct. 31	Nov. 2	Slight.	Very slight.	0.70	**4.05**	**2.10**	**1.95**	.0004	.0260 **.0236**	.26	.0050	.0001
3630	Dec. 3	Dec. 4	Very slight.	Very slight.	0.90	**4.00**	**2.00**	**2.00**	.0016	.0302 **.0272**	.26	.0080	.0002
	1889.												
3800	Jan. 1	Jan. 2	Slight.	Very slight.	0.90	**3.55**	**1.65**	**1.90**	.0016	.0274 **.0252**	.26	.0070	.0003
3954	Feb. 4	Feb. 6	Slight.	Slight.	0.75	**3.40**	**1.30**	**2.10**	.0008	.0228 **.0178**	.23	.0150	.0004
4197	Mar. 4	Mar. 5	Very slight.	Very slight	0.80	**3.40**	**1.65**	**1.75**	.0012	.0210 **.0182**	.25	.0120	.0002
4440	Apr. 1	Apr. 2	Slight.	Very slight	0.70	**3.40**	**1.40**	**2.00**	.0000	.0214 **.0182**	.21	.0070	.0002
4595	May 1	May 2	Distinct.	Slight.	0.60	**3.65**	**1.50**	**2.15**	.0000	.0256 **.0204**	.23	.0030	.0003
Av..	....	....	....	....	0.73	3.75	1.52	2.23	.0006	.0260	.23	.0056	.0001

Hardness in May, 1888, 1.3. Odor, generally vegetable, frequently disagreeable. —— The samples were collected from the reservoir, near the gate-house, at a depth of one foot beneath the surface. For monthly record of heights of water in this reservoir, see page 62.

Microscopical Examination.

	1888.							1889.				
	June.	July.	Aug.	Sept.	Oct.	Nov	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ, ...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	16.5	1.2	11.0	4.7	0.2	0.9	0.0	0.1	0.3	0.2	0.9	0.9
3. Fungi, ...	0.0	0.0	0.0	0.0	pr.	pr.	0.0	pr.	0.0	0.0	pr.	0.0
4. Animal Forms, ...	pr.	0.3	0.7	0.1	0.4	0.1	0.0	0.0	0.1	pr.	pr.	0.1

Groups and principal genera of organisms observed: 2. Palmellaceæ, *Chlorococcus;* Zoosporeæ, *Scenedesmus;* Desmidiaceæ, *Staurastrum;* Diatomaceæ, *Synedra.* 3. Schizomycetes. 4. Protozoa; Spongiaria; Rotifera; Entomostraca.

SUDBURY RIVER SUPPLY. — *Chemical Examination of Water from Reservoir No. 4, in Ashland, collected twenty feet beneath the surface.*

[Parts per 100,000.]

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.
	1887.												
16	May 31	June 1	Slight.	None.	0.80	3.66	1.33	2.33	.0008	.0197	–	–	–
236	June 30	July 1	Slight.	Very slight.	0.80	3.75	1.35	2.40	.0002	.0187	.26	.0065	–
461	Aug. 1	Aug. 2	Slight.	None.	0.75	3.47	1.47	2.00	.0006	.0166	.21	.0070	–
652	Aug. 31	Sept. 1	Very slight.	None.	0.70	3.72	1.32	2.40	.0000	.0274	.21	.0030	–
864	Oct. 3	Oct. 4	Very slight.	None.	0.60	3.65	1.45	2.20	.0002	.0232	.24	.0030	–
1073	Oct. 31	Nov. 1	Very slight.	Slight.	0.70	3.60	1.30	2.30	.0000	.0298	.25	.0030	–
1284	Nov. 30	Dec. 1	Very slight.	Slight.	0.50	3.70	1.45	2.25	.0008	.0241	.25	.0020	–
	1888.												
1514	Jan. 2	Jan. 3	Slight.	Slight.	0.70	4.05	1.40	2.65	.0019	.0255	.32	.0010	.0000
1717	Feb. 1	Feb. 1	Slight.	Slight.	0.70	4.35	1.70	2.65	.0026	.0251	.20	.0100	.0000
1927	Mar. 1	Mar. 2	Slight.	Slight.	0.50	4.25	1.70	2.55	.0030	.0263	.27	.0090	.0000
2137	Apr. 2	Apr. 3	Slight.	Slight.	0.70	4.65	1.45	3.20	.0167	.0260	.26	.0100	.0003
2331	May 1	May 2	Distinct.	Slight.	0.90	3.85	1.70	2.15	.0000	.0256	.21	.0050	.0002
2547	June 4	June 5	Very slight.	Considerable.	0.90	3.50	1.35	2.15	.0000	.0278 .0220	.22	.0030	.0001
2702	July 2	July 3	Distinct.	Slight.	0.40	3.65	1.10	2.55	.0006	.0252 .0214	.24	.0050	.0001
2864	Aug. 1	Aug. 2	Very slight.	Very slight.	0.90	3.90	1.75	2.15	.0004	.0250 .0242	.24	.0000	.0003
3043	Sept. 4	Sept. 5	Distinct.	Slight.	0.50	3.65	1.60	2.05	.0000	.0262 .0204	.16	.0030	.0001
3290	Oct. 1	Oct. 2	Slight.	Slight, green.	0.70	3.75	1.80	1.95	.0000	.0280 .0250	.19	.0020	.0001
3488	Oct. 31	Nov. 2	Slight.	Very slight.	0.75	4.00	1.85	2.15	.0000	.0274 .0268	.25	.0070	.0001
3631	Dec. 3	Dec. 4	Slight.	Slight.	0.90	3.85	1.85	2.00	.0012	.0262 .0240	.25	.0050	.0004

Chemical Examination of Water from Reservoir No. 4, in Ashland — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance: Turbidity.	Appearance: Sediment.	Appearance: Color.	Residue on Evaporation: Total.	Residue on Evaporation: Loss on Ignition.	Residue on Evaporation: Fixed.	Ammonia: Free.	Ammonia: Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
3801	Jan. 1	Jan. 2	Very slight.	Very slight.	0.90	3.85	1.70	2.15	.0010	.0264 .0210	.25	.0070	.0003
3955	Feb. 4	Feb. 6	Slight.	Slight.	0.75	3.40	1.25	2.15	.0014	.0220 .0172	.22	.0150	.0002
4198	Mar. 4	Mar. 5	Very slight.	Very slight.	0.80	3.60	1.70	1.90	.0010	.0212 .0176	.25	.0120	.0001
4441	Apr. 1	Apr. 2	Very slight.	Very slight.	0.70	3.40	1.40	2.00	.0000	.0210 .0186	.21	.0070	.0001
4596	May 1	May 2	Distinct.	Slight.	0.65	3.50	1.35	2.15	.0000	.0216 .0184	.22	.0050	.0002
Av.	....	....	....	....	0.72	3.89	1.47	2.42	.0014	.0244	.23	.0057	.0002

Hardness in May, 1888, 1.3. Odor, generally vegetable, frequently disagreeable. —— The samples were collected from the reservoir, near the gate-house, at a depth of 20 feet beneath the surface.

Microscopical Examination.

	1888. June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	1889. Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ, ...	pr.	0.0	0.0	pr.	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	8.4	3.4	0.3	3.5	0.4	0.1	0.0	0.3	0.3	0.5	1.3	0.2
3. Fungi, ...	0.0	pr.	pr.	pr.	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, ...	pr.	2.3	pr.	0.5	0.1	pr.	0.0	0.0	pr.	pr.	pr.	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ, *Staurastrum;* Diatomaceæ, *Synedra*. 3. Schizomycetes. 4. Protozoa, *Trachelomonas;* Spongiaria; Rotifera; Entomostraca.

Sudbury River Supply. — *Chemical Examination of Water from Reservoir No. 4, in Ashland, collected near the bottom.*

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance: Turbidity.	Appearance: Sediment.	Appearance: Color.	Residue on Evaporation: Total.	Residue on Evaporation: Loss on Ignition.	Residue on Evaporation: Fixed.	Ammonia: Free.	Ammonia: Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
17	May 31	June 1	Slight.	None.	0.80	4.12	1.75	2.37	.0016	.0210	–	–	–
237	June 30	July 1	Slight.	Slight.	0.70	4.20	1.17	3.03	.0010	.0235	.26	.0040	–
462	Aug. 1	Aug. 2	Very slight.	Slight.	0.75	3.60	1.32	2.28	.0037	.0162	.17	.0070	–
653	Aug. 31	Sept. 1	Very slight.	None.	0.70	3.55	1.20	2.35	.0021	.0192	.18	.0070	–

Chemical Examination of Water from Reservoir No. 4, in Ashland — Concluded.

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1887.												
865	Oct. 3	Oct. 4	Very slight.	Very slight.	0.75	3.67	1.35	2.32	.0019	.0201	.24	.0070	–
1074	Oct. 31	Nov. 1	Slight.	Slight.	0.50	3.85	1.55	2.30	.0006	.0352	.27	.0020	–
1285	Nov. 30	Dec. 1	Slight.	Slight.	0.40	3.70	1.50	2.20	.0005	.0262	.22	.0030	–
	1888.												
1515	Jan. 2	Jan. 3	Very slight.	Slight.	0.70	4.20	1.65	2.55	.0014	.0262	.19	.0030	.0000
1718	Feb. 1	Feb. 1	Slight.	Slight.	0.60	4.35	1.65	2.70	.0042	.0275	.20	.0120	.0000
1928	Mar. 1	Mar. 2	Very slight.	Slight.	0.60	4.40	1.65	2.75	.0032	.0270	.29	.0120	.0000
2138	Apr. 2	Apr. 3	Distinct.	Slight, earthy.	0.80	4.55	1.30	3.25	.0158	.0270	.29	.0100	.0003
2332	May 1	May 2	Distinct.	Slight.	0.80	3.80	1.70	2.10	.0004	.0226	.22	.0050	.0002
2548	June 4	June 5	Slight.	Slight.	0.80	4.25	1.75	2.50	.0000	.0242 .0206	.21	.0060	.0001
2703	July 2	July 3	Slight.	Slight.	0.70	3.55	1.95	1.60	.0008	.0244 .0192	.25	.0080	.0001
2865	Aug. 1	Aug. 2	Very slight.	Very slight.	0.90	4.05	1.60	2.45	.0010	.0254 .0168	.24	.0000	.0005
3044	Sept. 4	Sept. 5	Slight.	Considerable.	0.55	3.75	1.65	2.10	.0012	.0308 .0230	.17	.0020	.0001
3291	Oct. 1	Oct. 2	Distinct.	Slight, green.	0.60	3.50	1.50	2.00	.0000	.0242 .0236	.18	.0030	.0001
3489	Oct. 31	Nov. 2	Slight.	Very slight.	0.70	4.10	1.90	2.20	.0004	.0268 .0222	.25	.0050	.0001
3632	Dec. 3	Dec. 4	Very slight.	Very slight.	0.90	3.75	2.10	1.65	.0012	.0268 .0242	.27	.0050	.0003
	1889.												
3802	Jan. 1	Jan. 2	Slight.	Very slight.	0.90	3.80	1.75	2.05	.0008	.0270 .0228	.24	.0080	.0006
3956	Feb. 4	Feb. 6	Slight.	Slight.	0.75	3.45	1.30	2.15	.0016	.0210 .0184	.20	.0150	.0002
4199	Mar. 4	Mar. 5	Very slight.	Very slight.	0.80	3.50	1.45	2.05	.0012	.0216 .0182	.24	.0150	.0001
4442	Apr. 1	Apr. 2	Very slight.	Very slight.	1.00	3.40	1.40	2.00	.0002	.0190 .0186	.22	.0070	.0003
4597	May 1	May 2	Slight.	Slight.	0.75	3.55	1.55	2.00	.0008	.0228 .0178	.23	.0050	.0002
Av.	....	....	....	....	0.73	4.00	1.48	2.52	.0019	.0244	.23	.0066	.0002

Hardness in May, 1888, 1.4. Odor, generally vegetable, frequently disagreeable. —— The samples were collected from the reservoir, near the gate-house, at a depth of 40 feet beneath the surface, with the exception of Nos. 1074, 1285, 1515 and 1718, which were collected at 38, 30, 34 and 38 feet respectively beneath the surface.

Microscopical Examination.

	1888.							1889.					
	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ,	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ,	3.8	0.4	0.1	0.7	0.8	1.1	pr.	0.4	0.1	0.1	1.0	0.0
3 Fungi,	0.0	0.0	0.0	pr.	0.0	pr.	0.0	pr.	0.0	0.0	pr.	0.0
4. Animal Forms,	pr.	0.3	pr.	0.1	0.2	0.2	0.0	pr.	pr.	0.0	0.2	0.0

Groups and principal genera of organisms observed: 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Synedra*. 3. Schizomycetes. 4. Protozoa; Rotifera; Entomostraca.

SUDBURY RIVER SUPPLY. — *Chemical Examination of Water from Sudbury River at Upper End of Reservoir No. 2, in Ashland.*

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
18	May 31	June 1	Slight.	Slight.	1.50	4.01	1.58	2.43	.0019	.0291	-	-	-
227	June 30	July 1	Slight.	None.	1.00	5.17	1.80	3.37	.0038	.0310	.29	.0260	-
456	Aug. 1	Aug. 2	Very slight.	Slight.	0.90	5.10	1.17	3.93	.0034	.0275	.30	.0120	-
656	Aug. 31	Sept. 1	Very slight	Slight, rusty.	1.20	6.35	2.15	4.20	.0029	.0392	.36	.0130	-
866	Oct. 3	Oct. 4	Very slight.	Slight.	0.70	5.70	1.65	4.05	.0018	.0232	.51	.0260	-
1075	Oct. 31	Nov. 1	Very slight.	Slight, earthy.	1.10	5.00	1.45	3.55	.0000	.0316	.43	.0100	-
1286	Nov. 30	Dec. 1	Very slight.	Very slight.	1.50	6.25	2.90	3.35	.0011	.0374	.43	.0150	-
	1888.												
1516	Jan. 2	Jan. 3	Distinct.	Slight, earthy.	1.00	4.47	1.82	2.65	.0037	.0277	.22	.0090	.0000
1722	Feb. 1	Feb. 2	Very slight.	Very slight.	1.50	5.70	2.25	3.45	.0049	.0244	.32	.0200	.0000
1932	Mar. 1	Mar. 2	Very slight.	Very slight.	0.80	4.65	1.85	2.80	.0002	.0259	.27	.0150	.0000
2139	Apr. 2	Apr. 3	Distinct.	Slight, earthy.	0.80	3.10	1.10	2.00	.0008	.0215	.19	.0080	.0001
2333	May 1	May 2	Slight.	Very slight.	1.10	3.85	1.85	2.00	.0000	.0278	.29	.0100	.0003
2544	June 4	June 4	Slight.	Slight.	1.40	4.85	2.30	2.55	.0004	.0372 .0350	.28	.0070	.0003
2695	July 2	July 3	Slight.	Slight.	1.30	5.00	2.25	2.75	.0020	.0288 .0238	.33	.0180	.0001
2868	Aug. 1	Aug. 3	Slight.	Slight.	0.85	4.50	1.65	2.85	.0026	.0284 .0234	.31	.0030	.0002
3045	Sept. 4	Sept. 5	Slight.	Slight.	1.80	6.75	2.55	4.20	.0048	.0444 .0380	.30	.0070	.0001
3299	Oct. 1	Oct. 2	Slight.	Slight.	2.00	5.70	3.15	2.55	.0014	.0390 .0350	.30	.0070	.0003
3475	Oct. 31	Nov. 1	None.	Very slight.	1.10	4.85	2.35	2.50	.0002	.0254 .0242	.35	.0080	.0002
3633	Dec. 3	Dec. 4	Very slight.	Slight, brown.	0.60	3.70	1.75	1.95	.0000	.0208 .0194	.31	.0180	.0002

Chemical Examination of Water from Sudbury River — Concluded.

Number.	Date of — Collection.	Date of — Examination.	Appearance. — Turbidity.	Appearance. — Sediment.	Appearance. — Color.	Residue on Evaporation. — Total.	Residue on Evaporation. — Loss on Ignition.	Residue on Evaporation. — Fixed.	Ammonia. — Free.	Ammonia. — Albuminoid.	Chlorine.	Nitrogen as — Nitrates.	Nitrogen as — Nitrites.
	1889.												
3803	Jan. 1	Jan. 2	Very slight.	Slight, earthy.	0.60	3.35	1.20	2.15	.0000	.0170 .0158	.27	.0110	.0004
3957	Feb. 4	Feb. 5	Slight.	Slight.	0.60	3.40	1.10	2.30	.0006	.0206 .0176	.27	.0100	.0002
4200	Mar. 4	Mar. 5	Very slight.	Very slight.	0.70	3.45	1.15	2.30	.0004	.0198 .0166	.30	.0190	.0003
4443	Apr. 1	Apr. 2	Very slight.	Very slight.	0.70	3.35	1.25	2.10	.0006	.0196 .0196	.27	.0070	.0003
4598	May 1	May 2	Slight.	Considerable.	1.40	4.55	2.20	2.35	.0012	.0326 .0290	.27	.0050	.0003
Av.	....	....	....	....	1.09	4.95	1.80	3.15	.0016	.0283	.31	.0123	.0002

Hardness in May, 1888, 1.4. Odor, generally faintly vegetable, seldom mouldy and disagreeable. —— The samples were collected from the river near the old dam at upper end of Reservoir No. 2, at a depth of one foot beneath the surface.

Microscopical Examination.

	1888. June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	1889. Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ,	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ,	5.1	2.0	0.8	0.5	0.4	0.1	0.1	0.9	1.1	0.9	2.1	0.4
3. Fungi,	2.1	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms,	0.1	0.2	1.7	0.3	pr.	0.0	0.0	pr.	0.0	0.1	0.3	0.3

Groups and principal genera of organisms observed: 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Stauroneis*, *Synedra*; Zygnemaceæ. 3. Schizomycetes, *Crenothrix*. 4. Protozoa, *Dinobryon*; Spongiaria; Rotifera; Entomostraca.

Sudbury River Supply. — *Chemical Examination of Water from Reservoir No. 2, in South Framingham.*

[Parts per 100,000.]

Number.	Date of — Collection.	Date of — Examination.	Appearance. — Turbidity.	Appearance. — Sediment.	Appearance. — Color.	Residue on Evaporation. — Total.	Residue on Evaporation. — Loss on Ignition.	Residue on Evaporation. — Fixed.	Ammonia. — Free.	Ammonia. — Albuminoid.	Chlorine.	Nitrogen as — Nitrates.	Nitrogen as — Nitrites.
	1887.												
19	May 31	June 1	Decided.	Slig't, rusty.	1.40	4.60	2.38	2.22	.0024	.0297	–	–	–
234	June 30	July 1	Slight.	Slight.	1.30	5.17	1.72	3.45	.0039	.0365	.29	.0060	–
457	Aug. 1	Aug. 2	Slight.	Slight.	0.90	5.12	1.90	3.22	.0004	.0293	.31	.0070	–
657	Aug. 31	Sept. 1	Slight.	None.	0.80	4.95	1.72	3.23	.0006	.0335	.30	.0000	–
867	Oct. 3	Oct. 4	Slight.	Consid'ble.	1.30	5.57	2.20	3.37	.0006	.0398	.41	.0070	–
1076	Oct. 31	Nov. 1	Slight.	Slight.	1.00	4.05	1.05	3.00	.0012	.0320	.34	.0030	–
1287	Nov. 30	Dec. 1	Slight.	Slight.	0.90	5.10	2.10	3.00	.0013	.0340	.36	.0060	–

Chemical Examination of Water from Reservoir No. 2 — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
1517	Jan. 2	Jan. 3	Very slight.	Very slight.	1.60	6.05	2.35	3.70	.0026	.0350	.36	.0100	.0000
1723	Feb. 1	Feb. 2	Very slight.	Very slight.	1.30	6.05	2.80	3.25	.0012	.0258	.32	.0250	.0000
1931	Mar. 1	Mar. 2	Slight.	Very slight.	0.80	4.25	1.75	2.50	.0003	.0243	.23	.0150	.0000
2142	Apr. 2	Apr. 3	Very slight.	Very slight.	0.70	3.05	1.15	1.90	.0000	.0183	.20	.0080	.0001
2334	May 1	May 2	Distinct.	Very slight.	0.90	3.55	1.50	2.05	.0000	.0268	.35	.0120	.0003
2553	June 6	June 7	Slight.	Considerable.	1.30	4.20	1.90	2.30	.0002	.0324 .0240	.29	.0040	.0001
2713	July 5	July 6	Distinct.	Considerable.	1.00	4.55	2.15	2.40	.0006	.0300 .0224	.30	.0070	.0000
2867	Aug. 1	Aug. 3	Distinct.	Slight, green.	0.90	4.95	1.80	3.15	.0000	.0344 .0244	.34	.0030	.0001
3046	Sept. 4	Sept. 5	Distinct.	Considerable, green.	0.70	4.55	2.00	2.55	.0000	.0398 .0278	.25	.0050	.0001
3293	Oct. 1	Oct. 2	Very slight.	Very slight.	1.70	5.70	2.85	2.85	.0008	.0428 .0396	.29	.0070	.0002
3476	Oct. 31	Nov. 1	Slight.	Very slight.	1.50	4.85	2.15	2.70	.0000	.0308 .0270	.36	.0080	.0002
3634	Dec. 3	Dec. 4	Slight.	Slight.	0.60	3.80	1.70	2.10	.0002	.0198 .0188	.31	.0180	.0003
	1889.												
3804	Jan. 1	Jan. 2	Very slight.	Slight, earthy.	0.60	3.40	1.25	2.15	.0000	.0198 .0180	.27	.0130	.0006
3958	Feb. 4	Feb. 5	Slight.	Very slight.	0.60	3.35	0.85	2.50	.0000	.0220 .0182	.26	.0150	.0001
4201	Mar. 4	Mar. 5	Very slight.	Very slight.	0.55	3.25	1.20	2.05	.0008	.0218 .0190	.26	.0110	.0003
4444	Apr. 1	Apr. 2	Very slight.	Very slight.	0.90	3.20	1.20	2.00	.0008	.0190 .0176	.26	.0070	.0004
4590	May 1	May 2	Distinct.	Slight.	1.00	3.90	1.80	2.10	.0010	.0322 .0236	.27	.0070	.0002
Av.	....	....	....	....	1.01	4.79	1.88	2.91	.0008	.0296	.30	.0089	.0002

Hardness in May, 1888, 1.1. Odor, generally vegetable, occasionally mouldy and disagreeable. —— The samples were collected from the reservoir, near the gate-house, at a depth of 8 feet beneath the surface. For monthly record of heights of water in this reservoir, see page 62.

Microscopical Examination.

	1888. June.	1888. July.	1888. Aug.	1888. Sept.	1888. Oct.	1888. Nov.	1888. Dec.	1889. Jan.	1889. Feb.	1889. Mar.	1889. Apr.	1889. May.
1. Blue-green Algæ, ...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	4.2	16.2	6.0	1.8	1.1	0.1	pr.	0.5	pr.	0.1	3.8	4.6
3. Fungi, ...	0.0	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, ...	pr.	0.8	1.5	0.2	pr.	1.2	pr.	pr.	0.0	2.0	0.2	pr.

Groups and principal genera of organisms observed: 2. Palmellaceæ; Zoosporeæ, *Scenedesmus;* Desmidiaceæ; Diatomaceæ, *Fragillaria*, *Synedra*. 3. Schizomycetes. 4. Protozoa, *Peridinium;* Rotifera; Entomostraca.

SUDBURY RIVER SUPPLY. — *Chemical Examination of Water from Stony Brook at Upper End of Reservoir No. 3, in Southborough.*

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
21	May 31	June 2	Very slight.	Very slight.	1.30	7.45	3.83	3.62	.0058	.0427	0.46	–	–
228	June 30	July 1	Very slight.	Very slight.	1.10	6.62	2.35	4.27	.0039	.0338	0.50	.0100	–
458	Aug. 1	Aug. 2	Very slight.	Slight.	0.80	7.62	1.55	6.07	.0013	.0283	0.77	.0090	–
659	Aug. 31	Sept. 1	None.	Very slight.	1.10	8.92	1.90	7.02	.0036	.0446	0.86	.0130	–
868	Oct. 3	Oct. 4	Very slight.	Slight.	0.55	6.97	1.37	5.60	.0001	.0266	0.87	.0130	–
1077	Oct. 31	Nov. 1	Very slight.	Consid'ble, earthy.	0.75	8.40	2.65	5.75	.0000	.0370	1.08	.0180	–
1288	Nov. 30	Dec. 1	Distinct.	Slight.	1.20	8.20	2.85	5.35	.0057	.0355	0.66	.0280	–
	1888.												
1518	Jan. 2	Jan. 3	Decided.	Consid'ble, earthy.	0.75	5.25	1.90	3.35	.0136	.0289	0.26	.0200	.0005
1724	Feb. 1	Feb. 2	Very slight.	Very slight.	0.90	7.50	2.30	5.20	.0108	.0211	0.58	.0650	.0002
1933	Mar. 1	Mar. 2	Slight.	Very slight.	0.70	5.45	1.75	3.70	.0033	.0241	0.41	.0400	.0002
2141	Apr. 2	Apr. 3	Distinct.	Slight.	0.70	4.45	1.25	3.20	.0017	.0250	0.27	.0150	.0002
2335	May 1	May 2	Distinct.	Slight.	1.00	5.75	2.10	3.65	.0032	.0290	0.50	.0200	.0008
2545	June 4	June 4	Slight.	Slight.	1.90	6.20	2.45	3.75	.0014	.0442 .0392	0.38	.0250	.0006
2696	July 2	July 3	Distinct.	Slight.	1.70	6.85	2.60	4.25	.0040	.0370 .0336	0.61	.0120	.0009
2871	Aug. 1	Aug. 3	Very slight.	Very slight.	0.80	7.05	1.75	5.30	.0034	.0278 .0278	0.94	.0020	.0002
3047	Sept. 4	Sept. 5	Very slight.	Slight.	0.90	7.65	2.70	4.95	.0036	.0414 .0406	0.63	.0050	.0002
3294	Oct. 1	Oct. 2	None.	Very slight.	2.10	7.50	3.00	4.50	.0014	.0466 .0388	0.48	.0750	.0001
3477	Oct. 31	Nov. 1	Very slight.	Very slight.	1.90	6.20	2.30	3.90	.0006	.0296 .0282	0.55	.0300	.0002
3635	Dec. 3	Dec. 4	Very slight.	Very slight.	0.55	5.15	1.95	3.20	.0000	.0196 .0176	0.54	.0550	.0004
	1889.												
3805	Jan. 1	Jan. 2	Very slight.	Very slight.	0.60	4.45	1.30	3.15	.0036	.0178 .0152	0.44	.0550	.0008
3959	Feb. 4	Feb. 5	Slight.	Slight.	0.50	4.85	1.60	3.25	.0096	.0180 .0166	0.45	.0450	.0005
4202	Mar. 4	Mar. 5	Distinct.	Very slight.	0.60	5.15	1.55	3.60	.0202	.0224 .0192	0.50	.0400	.0010
4445	Apr. 1	Apr. 2	Very slight.	Very slight.	0.65	5.05	1.95	3.10	.0078	.0260 .0234	0.47	.0200	.0008
4600	May 1	May 2	Slight.	Slight.	1.45	5.70	2.40	3.30	.0036	.0358 .0326	0.41	.0150	.0006
Av.	....	....	....	....	1.02	6.88	2.15	4.73	.0047	.0309	0.57	.0274	.0005

Hardness in May, 1887, 1.8. Odor, generally faintly vegetable, seldom disagreeable. —— The samples were collected from Stony Brook about 50 feet below the first road above Reservoir No. 3, at a depth of one foot beneath the surface.

Microscopical Examination.

	1888.							1889.				
	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ, ...	0.0	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	pr.	0.0
2. Other Algæ, ...	3.5	1.0	1.4	3.2	1.3	pr.	0.1	0.7	0.6	0.4	1.1	1.0
3. Fungi, ...	3.0	0.2	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	pr.	0.0
4. Animal Forms, ...	0.1	0.4	0.5	1.2	pr.	pr.	0.0	0.0	0.0	pr.	0.1	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Melosira*, *Tabellaria*. 3. Schizomycetes, *Crenothrix*. 4. Protozoa; Rotifera; Entomostraca.

SUDBURY RIVER SUPPLY.— *Chemical Examination of Water from Reservoir No. 3, in Framingham.*

[Parts per 100,000.]

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.
	1887.												
20	May 31	June 2	Slight.	Slight.	1.00	5.20	3.15	2.05	.0068	.0215	.38	.0260	–
229	June 30	July 1	Slight.	Slight.	1.10	6.17	1.90	4.27	.0058	.0284	.40	.0450	–
459	Aug. 1	Aug. 2	Slight.	Slight.	0.90	5.27	1.77	3.50	.0008	.0303	.36	.0070	–
658	Aug. 31	Sept. 1	Slight.	None.	1.00	5.35	1.47	3.88	.0216	.0333	.42	.0030	–
869	Oct. 3	Oct. 4	Slight.	Very slight.	1.00	5.67	1.92	3.75	.0068	.0352	.48	.0130	–
1078	Oct. 31	Nov. 1	Very slight.	Slight.	0.70	5.55	2.20	3.35	.0066	.0386	.51	.0100	–
1289	Nov. 30	Dec. 1	Very slight.	Slight.	0.70	5.15	1.75	3.40	.0030	.0351	.49	.0150	–
	1888.												
1519	Jan. 2	Jan. 3	Distinct.	Slight, white.	1.20	5.65	1.65	4.00	.0054	.0386	.45	.0150	.0001
1725	Feb. 1	Feb. 2	Very slight.	None.	1.30	6.50	2.40	4.10	.0072	.0257	.39	.0450	.0001
1934	Mar. 1	Mar. 2	Distinct.	Slight.	0.60	4.45	1.25	3.20	.0085	.0209	.31	.0250	.0002
2140	Apr. 2	Apr. 3	Decided.	Slight.	0.60	3.75	1.00	2.75	.0062	.0230	.27	.0180	.0002
2336	May 1	May 2	Distinct.	Considerable.	0.90	4.30	1.70	2.60	.0012	.0282	.35	.0200	.0003
2554	June 6	June 7	Very slight.	Slight.	1.20	**5.10**	**1.95**	**3.15**	.0022	.0326 **.0252**	.38	.0200	.0007
2714	July 5	July 6	Slight.	Slight.	0.60	**5.05**	**2.20**	**2.85**	.0010	.0274 **.0252**	.42	.0250	.0004
2870	Aug. 1	Aug. 3	Very slight.	Very slight.	1.10	**3.10**	**1.10**	**2.00**	.0040	.0278 **.0254**	.46	.0090	.0005
3048	Sept. 4	Sept. 5	Slight.	Slight, green.	0.70	**5.45**	**1.90**	**3.55**	.0020	.0336 **.0256**	.44	.0060	.0002
3295	Oct. 1	Oct. 2	Distinct.	Slight.	0.80	**5.75**	**2.10**	**3.65**	.0028	.0368 **.0306**	.43	.0090	.0002
3478	Oct. 31	Nov. 1	Slight.	Very slight.	2.20	**5.95**	**2.30**	**3.65**	.0024	.0294 **.0266**	.50	.0250	.0002
3636	Dec. 3	Dec. 4	Slight.	Slight, earthy.	0.55	**4.75**	**1.90**	**2.85**	.0028	.0218 **.0182**	.45	.0450	.0007

Chemical Examination of Water from Reservoir No. 3 — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
3806	Jan. 1	Jan. 2	Distinct.	Slight.	0.60	4.35	1.50	2.85	.0020	.0180 .0152	.37	.0180	.0006
3960	Feb. 4	Feb. 5	Slight.	Very slight.	0.50	4.60	1.55	3.05	.0034	.0222 .0200	.42	.0350	.0004
4203	Mar. 4	Mar. 5	Slight.	Very slight.	0.55	4.40	1.50	2.90	.0076	.0230 .0184	.34	.0400	.0003
4446	Apr. 1	Apr. 2	Very slight.	Slight.	0.50	4.10	1.30	2.80	.0074	.0238 .0194	.37	.0300	.0005
4601	May 1	May 2	Slight.	Considerable.	0.60	4.50	1.65	2.85	.0002	.0280 .0214	.42	.0200	.0003
Av.	....	....	....	....	0.87	5.25	1.85	3.40	.0049	.0285	.40	.0218	.0003

Hardness in May, 1888, 1.7. Odor, generally faintly vegetable, seldom disagreeable. —— The samples were collected from the reservoir, near the gate-house, at a depth of 8 feet beneath the surface. For monthly record of heights of water in this reservoir, see page 62.

Microscopical Examination.

	1888. June.	1888. July.	1888. Aug.	1888. Sept.	1888. Oct.	1888. Nov.	1888. Dec.	1889. Jan.	1889. Feb.	1889. Mar.	1889. Apr.	1889. May.
1. Blue-green Algæ, ...	pr.	0.1	0.1	pr.	0.2	pr.	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	13.5	119.6	4.7	4.5	12.5	0.5	pr.	0.3	pr.	0.9	1.4	3.3
3. Fungi, ...	pr.	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, ...	0.9	0.8	0.1	1.0	1.9	pr.	0.0	0.0	0.0	0.4	0.5	4.4

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ, *Chlorococcus;* Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Asterionella, Melosira, Stephanodiscus, Synedra, Tabellaria.* 3. Schizomycetes. 4. Protozoa, *Dinobryon, Trachelomonas;* Rotifera; Entomostraca.

Sudbury River Supply. — *Chemical Examination of Water from Farm Pond, in Framingham.*

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
14	May 31	June 1	Slight, milky.	None.	1.00	4.70	2.15	2.55	.0090	.0236	–	–	–
231	June 30	July 1	None.	None.	0.80	5.35	1.35	4.00	.0060	.0275	.40	.0130	–
455	Aug. 1	Aug. 2	Slight.	None.	0.70	5.15	1.35	3.80	.0006	.0254	.38	.0030	–

Chemical Examination of Water from Farm Pond — Concluded.

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.
	1887.												
660	Aug. 31	Sept. 1	Slight.	Slight, rusty.	0.50	5.90	1.62	4.28	.0004	.0327	.39	.0000	–
870	Oct. 3	Oct. 4	Distinct.	Slight.	0.75	5.40	1.75	3.65	.0125	.0383	.40	.0090	–
1079	Oct. 31	Nov. 1	Slight.	Considerable.	0.70	4.55	1.40	3.15	.0006	.0348	.36	.0010	–
1290	Nov. 30	Dec. 1	Slight.	Slight.	0.90	4.85	1.95	2.90	.0010	.0290	.34	.0040	–
	1888.												
1520	Jan. 2	Jan. 3	Very slight.	Slight, white.	0.70	5.65	2.00	3.65	.0016	.0330	.39	.0080	.0000
1726	Feb. 1	Feb. 2	Very slight.	None.	1.00	5.80	2.20	3.60	.0045	.0245	.32	.0280	.0000
1935	Mar. 1	Mar. 2	Distinct.	Very slight.	0.60	5.35	1.30	4.05	.0079	.0232	.42	.0250	.0002
2143	Apr. 2	Apr. 3	Decided.	Considerable, white.	0.45	4.35	1.25	3.10	.0068	.0236	.34	.0180	.0003
2337	May 1	May 2	Decided.	Slight.	0.50	4.20	1.30	2.90	.0016	.0238	.34	.0120	.0004
2555	June 6	June 7	Slight.	Considerable, white.	0.70	4.75	1.65	3.10	.0034	.0264 .0174	.42	.0250	.0005
2715	July 5	July 6	Distinct.	Slight.	0.50	4.95	1.85	3.10	.0084	.0248 .0246	.40	.0200	.0003
2869	Aug. 1	Aug. 3	Slight.	Slight, green.	0.85	5.10	1.70	3.40	.0030	.0280 .0222	.37	.0070	.0002
3049	Sept. 4	Sept. 5	Slight.	Slight, white.	0.60	4.25	1.60	2.65	.0032	.0258 .0234	.27	.0030	.0001
3292	Oct. 1	Oct. 2	Slight, milky.	Slight.	0.60	5.00	1.60	3.40	.0116	.0312 .0274	.34	.0120	.0004
3479	Oct. 31	Nov. 1	Slight.	Very slight.	1.20	5.25	2.25	3.00	.0086	.0252 .0242	.39	.0200	.0003
3637	Dec. 3	Dec. 4	Slight.	Very slight.	0.75	5.65	1.60	4.05	.0098	.0226 .0208	.48	.0300	.0004
	1889.												
3807	Jan. 1	Jan. 2	Slight.	Slight.	0.50	5.25	1.65	3.60	.0040	.0186 .0182	.50	.0250	.0006
3961	Feb. 4	Feb. 5	Slight.	Slight.	0.55	5.85	1.55	4.30	.0050	.0240 .0202	.58	.0400	.0007
4204	Mar. 4	Mar. 5	Slight.	Considerable, light.	0.25	4.20	1.20	3.00	.0020	.0248 .0142	.40	.0280	.0004
4447	Apr. 1	Apr. 2	Slight.	Very slight.	0.15	4.55	1.05	3.50	.0010	.0182 .0140	.48	.0120	.0003
4602	May 1	May 2	Slight.	Slight.	0.30	5.15	1.15	4.00	.0008	.0208 .0166	.57	.0200	.0004
Av.	....	....	....	....	0.65	5.10	1.63	3.47	.0047	.0262	.40	.0158	.0003

Hardness in May, 1888, 1.6. Odor, generally vegetable, occasionally disagreeable. —— The samples were collected from the pond, at the gate-house. Algæ appeared in the pond in June, 1887, and from June 2 to Aug. 24, 1887, no water was drawn from the pond for the supply of the city. During this time no water was diverted into the pond from the reservoirs. For monthly record of heights of water in this pond, see page 62.

Microscopical Examination.

	1888.							1889.				
	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ, ...	pr.	0.0	4.0	pr.	pr.	0.0	0.0	0.0	0.0	0.0	0.0	pr.
2. Other Algæ, ...	5.0	0.5	7.0	8.0	0.7	pr.	0.0	1.4	0.4	0.0	4.3	1.1
3. Fungi, ...	0.0	0.1	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	pr.
4. Animal Forms, ...	pr.	0.1	pr.	0.6	0.3	0.0	0.0	0.0	2.4	450.8	3.2	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ, *Anabæna*. 2. Palmellaceæ, *Chlorococcus;* Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Asterionella*, *Stephanodiscus*, *Synedra;* Zygnemaceæ. 3. Schizomycetes. 4. Protozoa, *Dinobryon*, *Trachelomonas;* Annelida; Rotifera; Bryozoa; Entomostraca.

COCHITUATE SUPPLY.— *Chemical Examination of Water from Beaver Dam Brook at point of discharge into Lake Cochituate, in Natick.*

[Parts per 100,000.]

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.
	1887.												
23	May 31	June 2	Slight, milky.	Considerable.	1.00	8.25	3.48	4.77	.0098	.0447	0.35	.0260	-
230	June 30	July 1	Slight.	Slight.	0.85	8.00	1.80	6.20	.0044	.0304	0.56	.0130	-
454	Aug. 1	Aug. 2	Very slight	Slight.	0.60	8.25	1.35	6.90	.0014	.0256	0.72	.0260	-
668	Aug. 31	Sept. 1	Slight.	Considerable.	0.50	8.67	2.07	6.60	.0044	.0366	0.53	.0370	-
871	Oct. 3	Oct. 4	Decided.	Slight.	0.40	10.95	1.72	9.23	.0081	.0228	1.24	.0650	-
1080	Oct. 31	Nov. 1	Very slight.	Slight, earthy.	0.50	10.50 10.15	1.60 1.25	8.90 8.90	.0074	.0304 .0234	0.77	.0300	-
1291	Nov. 30	Dec. 1	Very slight.	Slight.	1.00	10.60	3.40	7.20	.0135	.0341	0.53	.0280	-
	1888.												
1521	Jan. 2	Jan. 3	Decided.	Much, earthy.	1.00	11.45 6.75	3.40 2.45	8.05 4.30	.0114	.0550 .0368	0.26	.0280	.0005
1727	Feb. 1	Feb. 2	Very slight.	Slight.	0.50	8.50	2.50	6.00	.0184	.0275	0.51	.0280	.0005
1936	Mar. 1	Mar. 2	Very slight.	Considerable.	0.70	6.50	1.95	4.55	.0129	.0295	0.31	.0180	.0002
2144	Apr. 2	Apr. 3	Decided.	Much, earthy.	1.00	6.30	2.20	4.10	.0139	.0412	0.33	.0100	.0003
2338	May 1	May 2	Slight.	Considerable.	1.40	7.55	2.40	5.15	.0130	.0388	0.39	.0090	.0007
2542	June 4	June 4	Very slight	Slight, earthy.	1.10	7.45	2.75	4.70	.0032	.0354 .0346	0.32	.0200	.0015
2698	July 2	July 3	Distinct.	Slight.	0.70	7.95	2.55	5.40	.0068	.0280 .0262	0.57	.0400	.0021
2874	Aug. 1	Aug. 3	Slight.	Very slight.	0.40	7.90	1.80	6.10	.0068	.0244 .0224	0.92	.0500	.0008

Chemical Examination of Water from Beaver Dam Brook — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
3050	Sept. 4	Sept. 5	Distinct.	Slight.	0.60	8.40	2.30	6.10	.0022	.0328 .0292	.59	.0180	.0002
3296	Oct. 1	Oct. 2	Slight.	Very slight.	1.90	8.30	3.15	5.15	.0032	.0476 .0402	.38	.0150	.0005
3480	Oct. 31	Nov. 1	Decided.	Slight, earthy.	1.70	7.40	2.55	4.85	.0064	.0342 .0282	.44	.0200	.0005
3638	Dec. 3	Dec. 4	Very slight	Slight, earthy.	0.80	6.45	2.60	3.85	.0126	.0270 .0210	.55	.0450	.0008
	1889.												
3808	Jan. 1	Jan. 2	Very slight.	Considerable, earthy.	0.80	6.00	1.90	4.10	.0110	.0222 .0200	.51	.0300	.0010
3962	Feb. 4	Feb. 5	Slight.	Considerable, earthy.	0.75	6.45	1.75	4.70	.0132	.0196 .0182	.47	.0480	.0006
4205	Mar. 4	Mar. 5	Decided.	Heavy, earthy.	0.55	6.45	1.90	4.55	.0104	.0210 .0162	.56	.0600	.0005
4418	Apr. 1	Apr. 2	Very slight.	Considerable, earthy.	0.80	5.85	2.10	3.75	.0134	.0246 .0218	.45	.0280	.0005
4603	May 1	May 2	Slight.	Slight.	1.20	6.85	2.60	4.25	.0038	.0372 .0312	.41	.0150	.0005
Av.	....	....	....	....	0.86	8.79	2.32	6.47	.0088	.0321	.53	.0295	.0007

Hardness in May, 1888, 3.0. Odor, generally vegetable and mouldy.——The samples were collected from the brook at Mill Street, a short distance above Lake Cochituate.

Microscopical Examination.

	1888. June	July.	Aug.	Sept.	Oct.	Nov.	Dec.	1889. Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ, ...	0.0	0.0	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	2.1	0.9	2.2	3.0	0.5	0.0	pr.	1.4	0.6	0.4	1.3	0.7
3. Fungi, ...	1.5	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, ...	0.0	pr.	pr.	pr.	0.1	0.0	0.0	pr.	0.0	0.0	0.2	0.1

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Cocconeis*, *Melosira*, *Stauroneis*, *Synedra*. 3. Schizomycetes, *Crenothrix*, *Leptothrix*. 4. Protozoa; Spongiaria.

Cochituate Supply. — *Chemical Examination of Water from Dudley Pond, in Wayland.*

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
4208	Mar. 4	Mar. 5	Very slight.	Very slight.	0.10	2.60	0.95	1.65	.0062	.0198 .0182	.24	.0150	.0000
4451	Apr. 1	Apr. 2	Very slight.	Very slight.	0.10	2.85	0.75	2.10	.0082	.0220 .0184	.21	.0090	.0001
4605	May 1	May 2	Very slight.	Slight.	0.20	2.75	0.75	2.00	.0034	.0208 .0176	.22	.0050	.0002
Av.	....	....	....	....	0.13	2.73	0.82	1.91	.0059	.0209 .0181	.22	.0097	.0001

Hardness in March, 1.6. Odor, faintly vegetable. —— The samples were collected from the pond near the surface.

Microscopical Examination.

	1889. March.	1889. April.	1889. May.
1. Blue-green Algæ, ...	0.0	0.0	0.0
2. Other Algæ, ...	0.4	9.1	0.3
3. Fungi, ...	0.0	0.0	0.0
4. Animal Forms, ...	2.8	4.0	0.0

Groups and principal genera of organisms observed: 2. Palmellaceæ; Diatomaceæ, *Asterionella*, *Melosira*, *Stephanodiscus*, *Synedra*, *Tabellaria*. 4. Protozoa, *Dinobryon*.

Cochituate Supply. — *Chemical Examination of Water from Lake Cochituate, in Wayland.*

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
22	May 31	June 2	Distinct.	Very slight.	0.30	5.28	2.43	2.85	.0018	.0161	.42	.0130	–
233	June 30	July 1	Slight.	Slight.	0.20	4.70	0.85	3.85	.0027	.0193	.43	.0130	–
463	Aug. 1	Aug. 2	Very slight.	None.	0.30	4.92	1.45	3.47	.0012	.0147	.39	.0070	–
670	Aug. 31	Sept. 1	Very slight.	None.	0.15	5.02	1.32	3.70	.0002	.0184	.44	.0070	–
872	Oct. 3	Oct. 4	Very slight.	None.	0.10	5.10	1.10	4.00	.0005	.0190	.47	.0070	–
1081	Oct. 31	Nov. 1	Very slight.	Considerable.	0.20	5.25	1.00	4.25	.0024	.0206	.49	.0100	–
1292	Nov. 30	Dec. 1	Slight.	Considerable.	0.20	5.30	1.50	3.80	.0033	.0220	.42	.0100	–

Chemical Examination of Water from Lake Cochituate — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
1523	Jan. 2	Jan. 3	Slight.	Sli't, green.	0.20	4.95	1.25	3.70	.0015	.0197	.40	.0090	.0001
1729	Feb. 1	Feb. 2	Slight.	Slight.	0.15	5.40	1.25	4.15	.0041	.0186	.42	.0200	.0000
1937	Mar. 1	Mar. 2	Slight.	Very slight.	0.30	5.45	1.20	4.25	.0049	.0200	.48	.0180	.0001
2145	Apr. 2	Apr. 3	Slight.	Sli't, white.	0.20	5.05	1.10	3.95	.0016	.0197	.43	.0180	.0001
2339	May 1	May 2	Decided.	Consid'ble.	0.30	4.80	1.35	3.45	.0010	.0256	.40	.0120	.0003
2556	June 6	June 7	Slight.	Slight, white.	0.35	4.78	1.18	3.60	.0030	.0254 .0176	.40	.0200	.0004
2716	July 5	July 6	Distinct.	Very slight.	0.10	3.05	1.00	2.05	.0034	.0232 .0192	.42	.0180	.0004
2872	Aug. 1	Aug. 3	Very slight.	Slight.	0.10	5.20	1.25	3.95	.0008	.0234 .0196	.44	.0020	.0003
3051	Sept. 4	Sept. 5	Very slight.	Very slight, white.	0.05	4.90	1.05	3.85	.0012	.0230 .0186	.41	.0000	.0001
3297	Oct. 1	Oct. 2	Slight.	Slight, white.	0.05	4.70	1.25	3.45	.0004	.0200 .0166	.42	.0050	.0002
3481	Oct. 31	Nov. 1	Slight.	Slight.	0.25	4.90	1.50	3.40	.0098	.0200 .0162	.43	.0120	.0004
3639	Dec. 3	Dec. 4	Very slight.	Very slight.	0.20	5.60	1.55	4.05	.0074	.0212 .0182	.46	.0180	.0007
	1889.												
3809	Jan. 1	Jan. 2	Very slight.	Slight.	0.50	5.40	1.60	3.80	.0042	.0208 .0178	.46	.0250	.0006
3963	Feb. 4	Feb. 5	Slight, milky.	Slight.	0.45	5.35	2.00	3.35	.0050	.0212 .0178	.44	.0250	.0003
4206	Mar. 4	Mar. 5	Slight.	Con., light green.	0.50	5.10	1.70	3.40	.0002	.0210 .0182	.48	.0300	.0002
4449	Apr. 1	Apr. 2	Very slight.	Con., light green.	0.35	5.05	1.60	3.45	.0012	.0218 .0172	.46	.0300	.0002
4604	May 1	May 2	Very slight.	Slight.	0.45	4.50	1.20	3.30	.0014	.0212 .0184	.46	.0250	.0003
Av.	....	....	....	....	0.25	5.09	1.22	3.87	.0026	.0207	.44	.0148	.0003

Hardness in May, 1888, 1.8. Odor, generally faintly vegetable. —— The samples were collected in the gate-house. For monthly record of heights of water in this lake, see page 62.

Microscopical Examination.

	1888. June.	1888. July.	1888. Aug.	1888. Sept.	1888. Oct.	1888. Nov.	1888. Dec.	1889. Jan.	1889. Feb.	1889. Mar.	1889. Apr.	1889. May.
1. Blue-green Algæ, ...	0.4	0.1	0.1	0.1	pr.	pr.	0.0	0.0	0.0	0.0	0.0	pr.
2. Other Algæ, ...	8.9	0.4	4.4	2.6	2.0	10.7	7.5	16.1	17.2	28.9	18.1	52.4
3. Fungi, ...	0.0	pr.	0.0	0.0	pr.	0.0	0.4	0.1	0.0	0.0	0.0	0.0
4. Animal Forms, ...	pr.	pr.	pr.	pr.	0.2	0.2	pr.	0.2	0.9	1.0	1.9	2.1

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ, *Chlorococcus;* Zoosporeæ, *Synedra;* Desmidiaceæ; Diatomaceæ, *Asterionella*, *Melosira*, *Stephanodiscus*, *Synedra*, *Tabellaria*. 3. Schizomycetes. 4. Protozoa, *Dinobryon;* Spongiaria; Rotifera; Entomostraca.

COCHITUATE WORKS. — *Chemical Examination of Water from Chestnut Hill Distributing Reservoir.*

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
36	June 3	June 4	Very slight.	Very slight.	0.20	5.27	1.97	3.30	.0052	.0170	.37	.0320	–
241	July 1	July 1	Slight.	None.	0.55	5.57	1.27	4.30	.0019	.0202	.41	.0330	–
449	Aug. 1	Aug. 1	Very slight.	Slight.	0.40	4.72	0.90	3.82	.0027	.0169	.36	.0090	–
666	Sept. 1	Sept. 1	Slight.	Slight.	0.40	4.92	1.25	3.67	.0010	.0221	.40	.0070	–
881	Oct. 4	Oct. 4	Very slight.	Slight.	0.40	5.07	1.42	3.65	.0039	.0239	.45	.0100	–
1088	Nov. 2	Nov. 2	Slight.	Consid'ble.	0.40	5.05	1.50	3.55	.0002	.0300	.42	.0050	–
1306	Dec. 2	Dec. 2	Distinct.	Slight.	0.30	4.80	1.45	3.35	.0004	.0347	.35	.0040	–
	1888.												
1511	Jan. 2	Jan. 3	Very slight.	Slight.	0.70	5.10	1.45	3.65	.0018	.0278	.38	.0080	.0000
1709	Feb. 1	Feb. 1	Very slight.	Very slight.	0.70	5.30	1.80	3.50	.0030	.0226	.35	.0180	.0000
1924	Mar. 1	Mar. 1	Very slight.	Slight, white.	0.50	5.50	1.60	3.90	.0050	.0260	.48	.0250	.0001
2132	Apr. 2	Apr. 2	Distinct.	Slight, white.	0.35	4.85	1.25	3.60	.0016	.0212	.42	.0230	.0003
2345	May 2	May 2	Slight.	Con., green.	0.30	4.85	1.25	3.60	.0004	.0244	.41	.0250	.0004
2624	June 19	June 19	Very slight.	Slight, white.	0.40	**4.55**	**1.15**	**3.40**	.0038	.0196 **.0162**	.43	.0250	.0001
2742	July 9	July 9	Distinct.	Very slight.	0.40	**4.55**	**1.25**	**3.30**	.0002	.0226 **.0188**	.41	.0150	.0003
2884	Aug. 3	Aug. 4	Slight.	Slight, green.	0.20	**4.90**	**1.20**	**3.70**	.0002	.0204 **.0180**	.40	.0090	.0003
3072	Sept. 5	Sept. 6	Slight.	Very slight.	0.30	**4.60**	**1.35**	**3.25**	.0014	.0226 **.0190**	.37	.0150	.0002
3303	Oct. 2	Oct. 2	Slight.	Slight, green.	0.20	**4.60**	**1.35**	**3.25**	.0044	.0208 **.0162**	.35	.0120	.0003
3491	Nov. 1	Nov. 2	Very slight.	Very slight.	0.30	**5.05**	**1.65**	**3.40**	.0000	.0196 **.0196**	.40	.0200	.0002
3649	Dec. 4	Dec. 5	Very slight.	Very slight.	0.25	**5.10**	**1.50**	**3.60**	.0028	.0222 **.0198**	.45	.0350	.0004
	1889.												
3816	Jan. 2	Jan. 2	Very slight.	Very slight.	0.45	**4.55**	**0.75**	**3.80**	.0006	.0182 **.0162**	.43	.0280	.0003
3970	Feb. 5	Feb. 5	Very slight.	Very slight.	0.40	**5.25**	**1.65**	**3.60**	.0006	.0246 **.0220**	.44	.0400	.0003
4222	Mar. 5	Mar. 6	Very slight.	Very slight.	0.30	**4.25**	**1.35**	**2.90**	.0020	.0186 **.0140**	.40	.0280	.0002
4463	Apr. 2	Apr. 3	Very slight.	Slight.	0.45	**4.55**	**1.80**	**2.75**	.0016	.0192 **.0170**	.40	.0300	.0001
4612	May 3	May 3	Slight.	Very slight.	0.35	**4.50**	**1.30**	**3.20**	.0000	.0164 **.0142**	.41	.0250	.0003
Av.	....	....	....	....	0.38	5.08	1.43	3.65	.0019	.0222	.40	.0200	.0002

Hardness in May, 1888, 2.1. Odor, generally vegetable, seldom disagreeable. —— The samples were collected from the effluent gate-house.

Microscopical Examination.

	1888.							1889.				
	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ, ...	0.0	0.1	pr.	pr.	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2 Other Algæ, ...	3.5	4.2	2.6	0.7	0.3	6.6	2.5	10.1	0.2	6.2	2.2	13.2
3. Fungi, ...	0.0	0.0	0.0	0.0	0.0	0.1	0.4	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, ...	pr.	0.2	pr.	0.1	pr.	0.1	0.0	pr.	0.0	0.9	0.6	0.2

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ, *Chlorococcus;* Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Asterionella, Melosira, Stephanodiscus, Synedra, Tabellaria;* Zygnemaceæ. 3. Schizomycetes. 4. Protozoa; Spongiaria; Hydrozoa; Annelida; Rotifera; Bryozoa; Entomostraca.

Cochituate Works. — *Chemical Examination of Water from Brookline Distributing Reservoir.*

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
37	June 3	June 4	Very slight.	Very slight.	0.30	5.00	2.15	2.85	.0041	.0171	.42	.0190	–
240	July 1	July 1	Slight.	None.	0.60	5.20	1.15	4.05	.0025	.0242	.37	–	–
450	Aug. 1	Aug. 1	Very slight.	None.	0.40	4.95	0.90	4.05	.0034	.0166	.38	.0120	–
667	Sept. 1	Sept. 1	Slight.	Slight.	0.30	4.72	1.22	3.50	.0023	.0188	.40	.0070	–
880	Oct. 4	Oct. 4	Slight.	Slight.	0.45	5.20	1.37	3.83	.0025	.0263	.44	.0110	–
1087	Nov. 2	Nov. 2	Slight.	Slight, white.	0.40	4.80	1.35	3.45	.0002	.0293	.41	.0050	–
1307	Dec. 2	Dec. 2	Distinct.	Slight.	0.30	5.40	1.65	3.75	.0006	.0255	.39	.0080	–
	1888.												
1510	Jan. 2	Jan. 3	Slight.	Slight, white.	0.80	5.25	1.40	3.85	.0018	.0257	.41	.0090	.0000
1710	Feb. 1	Feb. 1	Very slight.	Very slight.	0.90	5.55	1.95	3.60	.0031	.0216	.37	.0230	.0000
1925	Mar. 1	Mar. 1	Very slight	Slight.	0.50	5.80	1.75	4.05	.0065	.0225	.49	.0300	.0001
2131	Apr. 2	Apr. 2	Distinct.	Slight, white.	0.30	4.80	0.95	3.85	.0008	.0229	.40	.0300	.0003
2344	May 2	May 2	Distinct.	Slight, green.	0.30	4.65	1.50	3.15	.0012	.0224	.41	.0200	.0003
2623	June 19	June 19	Very slight.	Slight, white.	0.45	4.95	1.45	3.50	.0048	.0188 .0156	.43	.0250	.0001
2744	July 9	July 9	Slight.	Slight.	0.60	4.80	1.70	3.10	.0010	.0240 .0184	.39	.0100	.0002
2885	Aug. 3	Aug. 4	Slight.	Slight, green.	0.30	5.00	1.25	3.75	.0026	.0218 .0200	.42	.0070	.0002
3071	Sept. 5	Sept. 6	Slight.	Slight.	0.40	4.50	1.40	3.10	.0010	.0246 .0190	.35	.0100	.0002

Chemical Examination of Water from Brookline Distributing Reservoir — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.	1888.											
3304	Oct. 2	Oct. 2	Slight.	Slight, green.	0.25	4.80	1.40	3.40	.0000	.0254 .0198	.37	.0150	.0003
3490	Nov. 1	Nov. 2	Distinct.	Slight.	0.40	5.25	1.55	3.70	.0002	.0280 .0190	.44	.0280	.0002
3650	Dec. 4	Dec. 5	Slight.	Very slight.	0.30	5.60	1.75	3.85	.0010	.0208 .0178	.48	.0350	.0004
	1889.	1889.											
3815	Jan. 2	Jan. 2	Very slight.	Slight.	0.50	4.35	0.80	3.55	.0006	.0186 .0164	.40	.0360	.0000
3969	Feb. 5	Feb. 5	Very slight.	Slight.	0.40	4.45	0.70	3.75	.0000	.0182 .0162	.41	.0380	.0004
4223	Mar. 5	Mar. 6	Very slight.	Slight.	0.35	4.55	1.40	3.15	.0002	.0168 .0136	.40	.0310	.0003
4461	Apr. 2	Apr. 3	Very slight.	Slight, green.	0.45	4.65	1.50	3.15	.0024	.0202 .0168	.37	.0200	.0002
4613	May 3	May 3	Slight.	Slight, white.	0.40	4.60	1.35	3.25	.0002	.0178 .0148	.40	.0250	.0003
Av.	....	....	....	....	0.43	5.11	1.45	3.66	.0018	.0220	.41	.0197	.0002

Hardness in May, 1888, 2.1. Odor, generally vegetable, seldom disagreeable.—— The samples were collected from the effluent gate-house.

Microscopical Examination.

	1888. June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	1889. Jan	Feb	Mar.	Apr.	May
1. Blue-green Algæ, ...	pr.	0.1	pr.	0.3	pr.	0.0	0.0	pr.	0.0	0.0	0.0	0.0
2. Other Algæ, ...	10.8	17.0	8.3	7.1	7.9	22.3	6.6	5.4	0.5	8.4	21.3	23 2
3. Fungi, ...	0.0	0.0	0.0	pr.	0.0	pr.	0.1	pr.	0.0	pr.	0 0	0.0
4. Animal Forms, ...	pr.	0.2	0.0	0.5	pr.	0.1	0.0	0.1	pr.	5.0	0 4	4 3

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ, *Chlorococcus*; Zoosporeæ, *Raphidium*, *Staurogenia*; Desmidiaceæ; Diatomaceæ, *Asterionella*, *Melosira*, *Stephanodiscus*, *Synedra*, *Tabellaria*. 3. Schizomycetes. 4. Protozoa, *Dinobryon*; Spongiaria; Rotifera; Entomostraca.

COCHITUATE WORKS. — *Chemical Examination of Water from Fisher Hill Distributing Reservoir.*

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
2622	June 19	June 19	Very slight.	Slight.	0.20	4.80	1.20	3.60	.0018	.0226 .0158	.44	.0200	.0002
2743	July 9	July 9	Slight.	Slight.	0.40	4.70	1.75	2.95	.0000	.0232 .0186	.39	.0150	.0003
2883	Aug. 3	Aug. 4	Slight.	Slight.	0.20	5.05	1.50	3.55	.0012	.0238 .0192	.41	.0070	.0003
3073	Sept. 5	Sept. 6	Slight.	Slight, green.	0.25	4.70	1.40	3.30	.0002	.0226 .0216	.36	.0070	.0002
3302	Oct. 2	Oct. 2	Slight.	Slight, green.	0.20	4.55	1.15	3.40	.0008	.0228 .0214	.36	.0100	.0001
3492	Nov. 1	Nov. 2	Very slight.	Very slight.	0.20	5.15	1.10	4.05	.0000	.0228 .0194	.43	.0250	.0002
3648	Dec. 4	Dec. 5	Very slight.	Very slight.	0.25	5.20	1.75	3.45	.0018	.0194 .0194	.45	.0400	.0003
	1889.												
3814	Jan. 2	Jan. 2	Very slight.	Very slight.	0.45	4.70	0.45	4.25	.0020	.0222 .0196	.45	.0430	.0000
3971	Feb. 5	Feb. 5	Very slight.	Slight.	0.35	4.90	1.25	3.65	.0002	.0208 .0170	.42	.0250	.0004
4224	Mar. 5	Mar. 6	Very slight.	Very slight.	0.30	4.65	1.40	3.25	.0002	.0182 .0168	.43	.0210	.0002
4462	Apr. 2	Apr. 3	Very slight.	Very slight, green.	0.40	4.60	1.55	3.05	.0014	.0198 .0168	.39	.0400	.0001
4614	May 3	May 3	Slight.	Slight, white.	0.50	4.60	1.35	3.25	.0004	.0182 .0170	.41	.0250	.0002
Av.	....	....	....	....	0.31	4.80	1.32	3.48	.0008	.0214 .0186	.41	.0226	.0002

Odor very faintly vegetable. —— The samples were collected from the reservoir.

Microscopical Examination.

	1888. June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	1889. Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ, ...	0.3	pr.	pr.	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	21.4	20.8	2.4	1.3	0.6	2.4	7.0	9.7	0.7	82.0	64.7	10.5
3. Fungi, ...	0.0	0.0	0.0	0.0	0.0	pr.	pr.	0.1	pr.	0.0	0.0	0.0
4. Animal Forms, ...	pr.	0.3	0.0	0.1	pr.	pr.	0.2	0.1	0.0	2.0	1.9	0.6

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ, *Chlorococcus;* Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Asterionella, Melosira, Stephanodiscus, Synedra, Tabellaria.* 3. Schizomycetes. 4. Protozoa, *Dinobryon;* Rotifera; Entomostraca.

COCHITUATE WORKS. — *Chemical Examination of Water from Parker Hill Distributing Reservoir.*

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
35	June 3	June 4	Slight.	Slight.	0.20	4.87	2.20	2.67	.0020	.0167	–	.0190	–
244	July 1	July 2	Very slight.	Considerable.	0.50	4.97	1.55	3.42	.0009	.0248	.37	.0260	–
465	Aug. 1	Aug. 2	Very slight.	Very slight.	0.40	5.05	1.75	3.30	.0010	.0180	.35	.0120	–
672	Sept. 1	Sept. 1	Slight.	Slight.	0.25	4.97	1.50	3.47	.0003	.0217	.40	.0070	–
882	Oct. 4	Oct. 5	Very slight.	Very slight.	0.35	5.30	1.30	4.00	.0000	.0276	.45	.0070	–
1161	Nov. 12	Nov. 12	Slight.	Slight.	0.30	5.05	1.70	3.35	.0000	.0271	.41	.0040	–
1308	Dec. 2	Dec. 3	Distinct.	Considerable.	0.40	5.40	1.55	3.85	.0004	.0247	.36	.0040	–
	1888.												
1525	Jan. 2	Jan. 3	Slight.	Slight, white.	0.30	3.95	0.85	3.10	.0016	.0232	.38	.0070	.0001
1720	Feb. 1	Feb. 1	Slight.	Slight.	0.50	6.15	2.20	3.95	.0046	.0294	.46	.0090	.0000
1919	Mar. 1	Mar. 1	Slight.	Slight, white.	0.10	3.15	0.65	2.50	.0058	.0165	.30	.0070	.0001
2129	Apr. 2	Apr. 2	Slight.	Very slight.	0.35	4.45	1.20	3.25	.0029	.0263	.38	.0080	.0002
2342	May 2	May 2	Slight.	Slight.	0.20	4.75	1.20	3.55	.0000	.0266	.39	.0010	.0002
2631	June 18	June 20	Very slight.	Slight, white.	0.10	4.55	1.10	3.45	.0010	.0210 .0154	.44	.0020	.0001
2878	Aug. 2	Aug. 3	Distinct.	Slight.	0.30	5.15	1.45	3.70	.0028	.0216 .0196	.40	.0090	.0002
Av.	....	....	....	....	0.30	4.84	1.47	3.37	.0017	.0232	.39	.0087	.0001

Hardness in May, 1888, 1.9; in June, 1889, 1.9. Odor, generally vegetable, seldom disagreeable. —— The samples were collected from the reservoir at the gate-house. No water was run into or drawn from the reservoir between Dec. 3, 1887, and July 2, 1888.

Microscopical Examination.

	1888. April.	1888. May.	1888. June.	1888. August.
1. Blue-green Algæ,	0.0	0.0	pr.	pr.
2. Other Algæ,	pr.	pr.	0.9	8.1
3. Fungi,	0.0	0.0	0.0	pr.
4. Animal Forms,	pr.	pr.	0.0	0.1

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ, *Chlorococcus;* Zoosporeæ; Desmidiaceæ; Diatomaceæ. 3. Schizomycetes. 4. Protozoa; Entomostraca.

Cochituate Works. — *Chemical Examination of Water from a Faucet at the Massachusetts Institute of Technology.*

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
466	Aug. 2	Aug. 2	Very slight.	Slight.	0.50	5.00	1.75	3.25	.0000	.0172	.35	.0120	–
671	Sept. 1	Sept. 1	Slight.	Very slight.	0.30	4.90	1.32	3.58	.0004	.0185	.48	.0130	–
876	Oct. 4	Oct. 4	Very slight.	Slight.	0.25	5.02	1.22	3.80	.0000	.0231	.43	.0100	–
1083	Nov. 1	Nov. 1	Slight.	Slight.	0.35	4.77	1.47	3.30	.0004	.0252	.43	.0050	–
1297	Dec. 1	Dec. 1	Distinct.	Slight, white.	0.35	4.75	1.10	3.65	.0003	.0284	.37	.0070	–
	1888.												
1526	Jan. 3	Jan. 3	Distinct.	Slight, white.	0.50	5.00	1.50	3.50	.0018	.0270	.38	.0080	.0000
1721	Feb. 2	Feb. 2	Very slight.	Very slight.	0.70	5.30	1.95	3.35	.0031	.0223	.39	.0250	.0000
1921	Mar. 1	Mar. 1	Very slight.	Slight, earthy.	0.70	5.55	1.70	3.85	.0039	.0209	.49	.0250	.0002
2130	Apr. 2	Apr. 2	Slight.	None.	0.30	4.90	1.20	3.70	.0014	.0212	.40	.0250	.0002
2341	May 2	May 2	Slight.	Very slight.	0.30	4.60	1.50	3.10	.0012	.0218	.39	.0180	.0004
2647	June 22	June 22	Very slight.	Slight.	0.30	**4.60**	**1.30**	**3.30**	.0004	.0194 **.0164**	.40	.0180	.0001
2766	July 13	July 13	Distinct.	Slight, rusty.	0.45	**4.85**	**1.80**	**3.05**	.0020	.0248 **.0218**	.39	.0150	.0002
2862	Aug. 2	Aug. 2	Distinct.	Slight, brown.	0.40	**4.90**	**1.15**	**3.75**	.0002	.0240 **.0214**	.42	.0180	.0002
3056	Sept. 5	Sept. 5	Slight.	Slight.	0.20	**4.60**	**1.35**	**3.25**	.0000	.0180 **.0180**	.36	.0070	.0001
3288	Oct. 2	Oct. 2	Slight.	Slight.	0.20	**4.60**	**1.50**	**3.10**	.0004	.0234 **.0194**	.35	.0100	.0002
3484	Nov. 1	Nov. 1	Very slight.	Very slight.	0.30	**5.15**	**1.65**	**3.50**	.0000	.0182 **.0162**	.42	.0200	.0001
3642	Dec. 4	Dec. 4	Very slight.	Very slight.	0.25	**5.25**	**1.70**	**3.55**	.0009	.0172 **.0136**	.44	.0300	.0004
	1889.												
3812	Jan. 2	Jan. 2	Slight.	Very slight.	0.40	**4.80**	**1.55**	**3.25**	.0006	.0172 **.0162**	.42	.0350	.0005
3965	Feb. 5	Feb. 5	Very slight.	Very slight.	0.35	**4.90**	**0.90**	**4.00**	.0000	.0184 **.0152**	.41	.0500	.0002
4211	Mar. 5	Mar. 5	Very slight.	Very slight.	0.45	**4.70**	**1.75**	**2.95**	.0004	.0176 **.0156**	.44	.0500	.0003
4459	Apr. 3	Apr. 3	Very slight.	Very slight.	0.45	**4.55**	**1.45**	**3.10**	.0010	.0150 **.0150**	.39	.0280	.0002
4611	May 3	May 3	Slight.	Slight.	0.40	**4.60**	**1.50**	**3.10**	.0006	.0174 **.0154**	.41	.0250	.0003
Av.	....	....	....	....	0.38	4.98	1.47	3.51	.0008	.0207	.41	.0206	.0002

Hardness in May, 1888, 1.9. Odor, generally vegetable, seldom disagreeable.

Microscopical Examination.

	1888.							1889.				
	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue green Algæ, ...	0.1	pr.	0.2	0.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	25.9	3.2	8.5	0.6	4.4	0.3	6.2	5.2	9.9	3.6	12.5	18.6
3. Fungi, ...	0.4	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	pr.
4. Animal Forms, ...	1.4	0.1	0.2	0.1	0.3	11.2	0.1	pr.	0.0	0.2	0.7	0.5

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ, *Chlorococcus;* Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Asterionella, Melosira, Stephanodiscus, Synedra, Tabellaria.* 3. Schizomycetes. 4. Protozoa, *Dinobryon, Hydromorum;* Spongiaria.

MYSTIC SUPPLY.— *Chemical Examination of Water from Mystic Lake.*

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
27	June 2	June 3	Slight.	Slight.	0.50	10.40	3.00	7.40	.0232	.0275	1.59	.0260	–
242	July 1	July 1	Slight.	Slight.	0.35	10.95	1.75	9.20	.0083	.0315	1.86	.0130	–
451	Aug. 1	Aug. 2	Distinct.	Slight.	0.30	10.40	1.10	9.30	.0004	.0259	1.89	.0160	–
678	Sept. 1	Sept. 3	Slight.	Slight.	0.20	11.30	0.90	10.40	.0035	.0312	2.32	.0130	–
884	Oct. 4	Oct. 5	Very slight.	Slight.	0.30	10.82	1.62	9.20	.0009	.0273	2.28	.0260	–
1097	Nov. 2	Nov. 3	Slight.	Slight.	0.20	10.90	1.15	9.75	.0066	.0222	2.26	.0400	–
1317	Dec. 2	Dec. 3	Slight.	Considerable.	0.10	11.00	1.80	9.20	.0370	.0205	2.19	.0500	–
	1888.												
1529	Jan. 3	Jan. 3	Slight.	Considerable, white.	0.20	11.95	1.70	10.25	.0540	.0254	2.32	.0450	.0018
1625	Jan. 18	Jan. 19	Distinct.	Slight.	0.20	11.70	1.70	10.00	.0573	.0227	2.30	.0500	–
1730	Feb. 1	Feb. 2	Slight.	Slight.	0.15	12.70	2.10	10.60	.0664	.0263	2.41	.0800	.0025
1922	Mar. 1	Mar. 1	Decided.	Very slight.	0.40	8.00	1.60	6.40	.0547	.0296	1.36	.0400	.0008
2133	Apr. 2	Apr. 2	Decided.	Very slight.	0.30	8.60	1.50	7.10	.0332	.0299	1.39	.0550	.0006
2347	May 2	May 3	Distinct.	Slight.	0.30	9.85	2.35	7.50	.0096	.0288	1.81	.0600	.0042
2583	June 12	June 12	Slight.	Slight.	0.20	9.65	1.30	8.35	.0120	.0278 .0252	1.78	.0450	.0025
2763	July 11	July 12	Slight.	Slight.	0.10	9.65	2.20	7.45	.0080	.0270 .0244	1.89	.0450	.0017
2876	Aug. 2	Aug. 3	Slight.	Slight.	0.15	10.25	1.20	9.05	.0000	.0262 .0212	2.09	.0170	.0010
3054	Sept. 4	Sept. 5	Slight.	Slight.	0.10	10.15	1.35	8.80	.0042	.0274 .0192	2.18	.0090	.0004
3306	Oct. 2	Oct. 3	Very slight.	Slight.	0.10	10.25	1.40	8.85	.0066	.0242 .0198	2.17	.0250	.0007
3501	Nov. 7	Nov. 8	Slight.	Slight.	0.30	11.05	2.30	8.75	.0144	.0240 .0214	2.08	.0400	.0010
3626	Nov. 30	Dec. 1	Decided.	Considerable.	0.25	9.40	2.15	7.25	.0274	.0246 .0220	1.78	.0560	.0020

Chemical Examination of Water from Mystic Lake — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
3817	Jan. 2	Jan. 3	Distinct.	Considerable, earthy	0.35	8.85	1.90	6.95	.0360	.0356 .0256	1.52	.1250	.0017
3972	Feb. 5	Feb. 5	Slight.	Considerable.	0.20	8.95	1.55	7.40	.0296	.0210 .0158	1.40	.1000	.0015
4218	Mar. 5	Mar. 6	Slight.	Very slight.	0.15	9.00	2.05	6.95	.0432	.0184 .0136	1.48	.1100	.0014
4457	Apr. 2	Apr. 3	Distinct.	Slight.	0.10	9.30	2.15	7.15	.0360	.0262 .0188	1.44	.1000	.0014
4609	May 2	May 2	Distinct.	Con., light green.	0.20	9.00	2.20	6.80	.0154	.0290 .0220	1.54	.0550	.0011
Av.	....	....	....	....	0.23	10.68	1.61	9.07	.0235	.0264	1.89	.0496	.0015

Hardness in May, 1888, 3.4. Odor, generally vegetable, mouldy, musty and disagreeable. —— The samples were collected from the lake, near the gate-house. For monthly record of heights of water in this lake, see page 62.

Microscopical Examination.

	1888. June.	1888. July.	1888. Aug.	1888. Sept.	1888. Oct.	1888. Nov.	1888. Dec.	1889. Jan.	1889. Feb.	1889. Mar.	1889. Apr.	1889. May.
1. Blue-green Algæ,	pr.	0.0	0.0	0.0	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ,	7.3	2.5	4.8	12.6	0.4	8.6	1.2	3.8	1.0	18.0	174.6	465.0
3. Fungi,	0.3	0.0	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms,	0.1	0.6	9.3	20.0	0.4	1.5	pr.	0.3	pr.	pr.	0.2	1.6

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ, *Chlorococcus;* Zoosporeæ, *Raphidium, Scenedesmus;* Desmidiaceæ; Diatomaceæ, *Asterionella, Melosira, Synedra, Tabellaria.* 3. Schizomycetes. 4. Protozoa, *Peridinium, Trachelomonas;* Rotifera; Entomostraca.

MYSTIC SUPPLY. — *Chemical Examination of Water from College Hill Distributing Reservoir.*

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
28	June 2	June 3	Decided.	Con., rusty.	0.50	10.52	3.37	7.15	.0082	.0284	1.64	.0910	–
243	July 1	July 1	Slight.	Slight.	0.35	10.80	1.75	9.05	.0056	.0268	1.86	.0260	–
452	Aug. 1	Aug. 2	Slight.	Very slight.	0.20	9.90	1.10	8.80	.0017	.0234	1.88	.0330	–
677	Sept. 1	Sept. 3	Slight.	Slight.	0.20	11.05	1.00	10.05	.0028	.0295	2.26	.0130	–
885	Oct. 4	Oct. 5	Very slight.	Slight.	0.32	10.97	1.22	9.75	.0004	.0245	2.34	.0350	–
1098	Nov. 2	Nov. 3	Slight.	Slight.	0.15	10.90	1.30	9.60	.0026	.0264	2.33	.0400	–
1318	Dec. 2	Dec. 3	Very slight.	Considerable.	0.10	11.10	1.60	9.50	.0328	.0209	2.70	.0500	–

Chemical Examination of Water from College Hill Distributing Reservoir — Con.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
1530	Jan. 3	Jan. 3	Slight.	Con., white	0.20	12.00	1.80	10.20	.0511	.0274	2.42	.0500	.0005
1626	Jan. 18	Jan. 19	Distinct.	Slight.	0.20	12.00	1.80	10.20	.0477	.0212	2.36	.0500	–
1731	Feb. 1	Feb. 2	Distinct.	Sli't., white.	0.15	12.25	1.80	10.45	.0686	.0262	2.42	.0800	.0015
1923	Mar. 1	Mar. 1	Distinct.	Con., white.	0.40	8.80	1.90	6.90	.0583	.0257	1.51	.0450	.0008
2134	Apr. 2	Apr. 2	Decided.	Sli't, earthy	0.25	8.90	1.80	7.10	.0344	.0250	1.44	.0500	.0008
2362	May 4	May 5	Distinct.	Slight.	0.40	9.35	1.85	7.50	.0032	.0244	1.77	.0700	.0025
2584	June 12	June 12	Slight.	Considerable.	0.20	9.35	1.35	8.00	.0040	.0284 .0220	1.74	.0500	.0018
2764	July 11	July 12	Distinct.	Slight.	0.20	11.10	2.00	9.10	.0032	.0254 .0206	1.88	.0400	.0010
2875	Aug. 2	Aug. 3	Slight.	Slight, white.	0.15	9.85	0.90	8.95	.0010	.0214 .0206	2.02	.0180	.0007
3055	Sept. 4	Sept. 5	Very slight.	Slight, white.	0.10	10.10	1.40	8.70	.0054	.0224 .0184	2.16	.0120	.0004
3305	Oct. 2	Oct. 3	Very slight.	Considerable.	0.05	10.55	1.55	9.00	.0024	.0262 .0200	2.16	.0200	.0003
3502	Nov. 7	Nov. 8	Slight.	Considerable.	0.30	10.95	2.10	8.85	.0050	.0248 .0222	2.10	.0500	.0015
3627	Nov. 30	Dec. 1	Very slight.	Slight.	0.20	10.20	2.20	8.00	.0250	.0240 .0192	1.92	.0600	.0020
	1889.												
3818	Jan. 2	Jan. 3	Slight.	Slight.	0.35	9.10	1.70	7.40	.0296	.0244 .0202	1.51	.1150	.0015
3973	Feb. 5	Feb. 5	Slight.	Slight.	0.20	8.80	1.75	7.05	.0360	.0194 .0164	1.39	.1100	.0020
4219	Mar. 5	Mar. 6	Slight.	Considerable.	0.15	9.15	2.10	7.05	.0456	.0186 .0118	1.49	.1000	.0008
4458	Apr. 2	Apr. 3	Distinct.	Slight.	0.10	9.35	2.00	7.35	.0464	.0184 .0142	1.47	.0800	.0017
4610	May 2	May 2	Distinct.	Con., light green.	0.20	9.00	2.05	6.95	.0036	.0314 .0190	1.56	.0800	.0014
Av.	....	....	....	....	0.22	10.67	1.58	9.09	.0210	.0246	1.93	.0547	.0013

Hardness in June, 1887, 3.8; in May, 1888, 3.4. Odor, generally vegetable, mouldy, musty and disagreeable. —— The samples were collected from the reservoir.

Microscopical Examination.

	1888. June.	1888. July.	1888. Aug.	1888. Sept.	1888. Oct.	1888. Nov.	1888. Dec.	1889. Jan.	1889. Feb.	1889. Mar.	1889. Apr.	1889. May.
1. Blue-green Algæ, . . .	0.0	0.0	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	12.3	1.2	0.3	10.1	1.3	9.8	5.7	9.5	0.2	3.3	190.0	1221.7
3. Fungi, ...	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, . . .	1.0	2.4	0.0	2.9	1.0	0.5	0.0	0.5	pr.	0.1	0.6	0.5

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ, *Scenedesmus*; Desmidiaceæ; Diatomaceæ, *Asterionella*, *Melosira*, *Synedra*, *Tabellaria*. 3. Schizomycetes. 4. Protozoa, *Dinobryon*, *Peridinium*; Spongiaria; Rotifera; Bryozoa.

Table showing the Average Monthly and Yearly Heights above Tide-marsh Level of the Water in the Lakes and Storage Reservoirs of the Boston Water Works, from which Samples of Water were collected.

MONTHS.	Reservoir No. 2. Flash boards. 167.12			Reservoir No. 3. Stone crest. 175.24			Reservoir No. 4. Flash boards. 215.21			Farm Pond. High Water. 149.25			Lake Cochituate. High Water. 134.36			Mystic Lake. High Water. 7.00		
	1887.	**1888.**	**1889.**	**1887.**	**1888.**	**1889.**	**1887.**	**1888.**	**1889.**	**1887.**	**1888.**	**1889.**	**1887.**	**1888.**	**1889.**	**1887.**	**1888.**	**1889.**
January,	–	165.86	166.26	–	175.39	175.60	–	210.46	214.72	–	149.27	149.25	–	125.97	130.71	–	5.31	5.25
February,	–	166.22	166.23	–	173.19	175.51	–	212.93	214.63	–	149.29	149.56	–	126.40	132.67	–	5.22	5.70
March,	–	165.29	166.02	–	172.94	175.32	–	213.83	214.44	–	149.27	149.83	–	129.35	132.31	–	5.22	5.50
April,	–	166.21	166.12	–	175.55	175.48	–	214.85	214.48	–	149.25	149.24	–	130.60	132.43	–	5.86	6.33
May,	–	166.17	166.23	–	175.51	175.60	–	215.07	214.59	–	149.28	149.43	–	130.14	133.61	–	6.51	6.26
June,	166.99	166.81	–	175.19	175.13	–	214.98	215.13	–	149.24	149.25	–	133.86	129.09	–	6.74	6.61	–
July,	164.43	164.26	–	174.26	174.45	–	214.87	215.11	–	149.13	149.26	–	132.59	127.31	–	6.11	5.78	–
August,	164.59	162.45	–	173.42	174.27	–	214.91	212.50	–	149.25	149.28	–	128.96	126.20	–	6.31	4.79	–
September,	163.18	164.26	–	173.11	175.43	–	214.86	212.80	–	149.23	148.31	–	126.63	126.42	–	5.90	5.11	–
October,	161.25	167.41	–	171.95	175.69	–	211.67	215.20	–	149.30	148.19	–	125.69	127.91	–	5.40	6.22	–
November,	162.84	167.38	–	173.22	175.58	–	206.10	215.02	–	149.26	149.27	–	125.27	127.89	–	5.65	5.82	–
December,	165.48	166.52	–	175.35	175.59	–	206.67	214.57	–	149.29	149.42	–	125.39	130.30	–	5.74	5.28	–

Chemical Examination of Water from Jamaica Pond.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
34	June 3	June 4	Decided, milky.	None.	0.00	7.72	3.52	4.20	.0022	.0618	.83	.0000	–
246	July 5	July 6	Decided.	Slight.	0.02	7.35	1.22	6.13	.0088	.0284	.84	.0000	–
461	Aug. 2	Aug. 2	Decided.	Sli't, white	0.10	6.77	1.10	5.67	.0035	.0266	.77	.0040	–
673	Sept. 2	Sept. 2	Decided.	Slight.	0.00	6.52	0.70	5.82	.0000	.0279	.85	.0000	–
879	Oct. 4	Oct. 4	Distinct.	Con., white.	0.00	6.70	0.92	5.78	.0007	.0263	.85	.0000	–
1304	Dec. 2	Dec. 2	Decided.	Slight, white.	0.00	6.90	0.75	6.15	.0475	.0336	.78	.0060	–
	1888.												
1576	Jan. 11	Jan. 11	Decided.	Slight, dark colored.	0.00	7.05	1.35	5.70	.0346	.0277	.88	.0180	.0002
1703	Feb. 1	Feb. 1	Distinct.	Very slight, white.	0.10	7.40	1.40	6.00	.0324	.0258	.83	.0200	.0005
1920	Mar. 1	Mar. 1	Distinct.	None.	0.10	6.30	1.25	5.05	.0438	.0269	.86	.0150	.0003
2147	Apr. 3	Apr. 3	Distinct.	Consid'ble.	0.10	6.50	0.60	5.90	.0352	.0278	.81	.0100	.0004
2343	May 2	May 2	Decided.	Very slight, white.	0.10	6.55	1.15	5.40	.0168	.0350	.82	.0180	.0006
2590	June 13	June 13	Slight.	Considera-ble.	0.00	6.85	1.25	5.60	.0066	.0244 .0158	.82	.0220	.0007
2750	July 11	July 11	Distinct.	Slight, white.	0.10	6.30	1.20	5.10	.0002	.0240 .0192	.83	.0020	.0003
2880	Aug. 3	Aug. 3	Very slight.	Very slight, white.	0.00	6.40	1.15	5.25	.0020	.0210 .0190	.87	.0000	.0001
3058	Sept. 5	Sept. 5	Decided.	Consid'ble, green.	0.05	6.25	1.05	5.20	.0000	.0376 .0180	.82	.0020	.0001
3301	Oct. 2	Oct. 2	Decided.	Consid'ble, earthy.	0.00	6.40	1.65	4.75	.0000	.0460 .0218	.79	.0050	.0002
3485	Nov. 1	Nov. 1	Decided.	Consid'ble, white.	0.00	6.50	1.20	5.30	.0272	.0482 .0178	.85	.0250	.0004
3643	Dec. 4	Dec. 4	Decided.	Slight.	0.00	6.20	1.35	4.85	.0300	.0476 .0166	.82	.0300	.0002
	1889.												
3813	Jan. 2	Jan. 2	Decided	Slight.	0.00	6.45	1.50	4.95	.0344	.0480 .0164	.84	.0380	.0006
3968	Feb. 5	Feb. 5	Decided.	Slight	0.00	6.40	0.90	5.50	.0240	.0620 .0170	.81	.0280	.0004
4216	Mar. 5	Mar. 5	Distinct.	Fibrous and sandy.	0.00	7.30	1.75	5.55	.0104	.0490 .0144	.86	.0500	.0003
4460	Apr. 3	Apr. 3	Decided.	Slight, white.	0.00	6.75	2.00	4.75	.0008	.0616 .0172	.82	.0500	.0002
4608	May 2	May 2	Distinct.	Slight.	0.00	6.75	1.55	5.20	.0000	.0990 .0172	.84	.0250	.0006
Av.	....	....	....	....	0.03	6.80	1.04	5.76	.0157	.0398	.83	.0160	.0004

Hardness in May, 1888, 3.0. Odor, generally vegetable, mouldy and disagreeable, increased on heating.—— The samples were collected from a faucet at the pumping station, while pumping, or from the pond near the conduit. The conduit is located at a depth of 6.5 feet below high water.

Microscopical Examination.

	1888.							1889.				
	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ, . . .	0.0	0.0	0.0	0.6	pr.	0.0	0.0	0.0	0.0	0.0	pr.	pr.
2. Other Algæ, ...	2.0	6.1	27.9	4.5	0.4	0.0	0.2	pr.	0.0	pr.	0.2	0.0
3. Fungi, ...	0.0	1.0	0.2	15.0	20.0	7.5	10.0	25.0	1.2	600.0	60.0	250.0
4. Animal Forms, . . .	pr.	0.3	pr.	pr.	0.4	0.8	pr.	0.0	0.0	0.0	pr.	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ, *Chlorococcus;* Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Synedra.* 3. Schizomycetes, *Oscillaria.* 4. Protozoa; Rotifera; Entomostraca.

WATER SUPPLY OF BRAINTREE. — BRAINTREE WATER SUPPLY COMPANY.

Description of Works.—Population in 1885, 4,040. The works are owned by the Braintree Water Supply Company.* Water was introduced in 1887. The source of supply is a filter-gallery on the eastern shore of Little Pond in South Braintree. Little Pond has an area of 75 acres when full, but when drawn down six feet its area is said to be but 48 acres. The owners of the water privilege at the outlet of the pond have the right to draw it down six feet. Its drainage area is about 350 acres, and there is quite a large population on this area, mostly in the village of South Braintree, which is on the same side of the pond as the filter-gallery. This village has no system of sewerage. The filter-gallery is 110 feet in length and 15 feet in width; its side walls are 13.5 feet high, built of granite laid dry. A brick arch forms the roof. The bottom of the gallery is 16.5 feet below high water in Little Pond. Water is pumped from the filter-gallery to an open iron tank 30 feet in diameter and 100 feet high. Distributing mains are of cast iron and service pipes of enameled iron.

Chemical Examination of Water from the Filter-Gallery of the Braintree Water Supply Company.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1887.												
213	June 28	June 29	Dec'd, milky	None.	0.50	8.15	–	–	.0019	.0122	0.81	.1040	–
434	July 28	July 29	Slight.	None.	0.15	7.50	–	–	.0010	.0042	0.77	.1560	–
663	Aug. 30	Sept. 1	None	None.	0.00	6.72	–	–	.0004	.0036	0.85	.1040	–
854	Sept. 23	Sept. 26	None.	None.	0.00	7.25	–	–	.0000	.0026	0.87	.0390	–
1068	Oct. 27	Oct. 29	None.	None.	0.00	7.35	–	–	.0000	.0016	0.86	.0750	–

* The question of the ownership of the water works in this town is a disputed one, which is now before the courts for settlement. The works are now operated by the company.

Chemical Examination of Water from the Filter-Gallery, Braintree — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
1305	Nov. 30	Dec. 2	None.	None.	0.00	6.45	–	–	.0000	.0036	0.81	.0600	–
1509	Dec. 30	Dec. 31	None.	None.	0.00	7.25	–	–	.0002	.0014	0.98	.0900	.0003
	1888.												
1706	Jan. 30	Feb. 1	Very slight.	None.	0.00	7.85	–	–	.0000	.0013	1.01	.1500	.0002
1930	Feb. 29	Mar. 2	Slight.	Slight.	0.00	7.60	–	–	.0004	.0036	0.91	.1600	.0005
2107	Mar. 26	Mar. 27	Very slight.	Very slight.	0.00	6.45	–	–	.0004	.0058	0.79	.0750	.0004
2326	Apr. 28	Apr. 30	Slight, milky.	Very slight.	0.10	6.60	–	–	.0018	.0060	0.80	.0650	.0001
2538	May 28	May 31	Slight, milky.	Slight, earthy.	0.05	6.50	–	–	.0008	.0076	0.76	.0600	.0001
Av.	....	....	....	....	0.07	7.14	–	–	.0006	.0045	0.85	.0948	.0003

Hardness in May, 1888, 2.7. Odor, none.——The samples were collected from a faucet in the pumping station while pumping.

Microscopical Examination.

	1888. March.	1888. April.	1888. May.
1. Blue-green Algæ, ...	0.0	0.0	0.0
2. Other Algæ, ...	pr.	pr.	pr.
3. Fungi, ...	0.0	0.0	0.0
4. Animal Forms, ...	0.0	0.0	0.0

Groups and principal genera of organisms observed: 2. Desmidiaceæ; Diatomaceæ.

Chemical Examination of Water from the Tank of the Braintree Water Supply Company.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
1707	Jan. 30	Feb. 1	Very slight.	None.	0.00	7.90	–	–	.0000	.0012	1.06	.1600	.0005
1929	Feb. 29	Mar. 2	None.	None.	0.00	7.35	–	–	.0004	.0050	0.95	.1600	.0004
2108	Mar. 26	Mar. 27	Very slight.	None.	0.00	6.65	–	–	.0002	.0030	0.82	.1000	.0010
2327	Apr. 28	Apr. 30	Slight, milky.	Very slight.	0.10	6.15	–	–	.0000	.0052	0.77	.0800	.0000
2539	May 29	May 31	Very slight, milky.	None.	0.05	6.25	–	–	.0000	.0052	0.77	.0650	.0001
Av.	....	....	....	....	0.03	6.86	–	–	.0001	.0039	0.87	.1130	.0004

Hardness in May, 1888, 2.7. Odor, none.——The samples were collected from faucets in houses in he vicinity of the tank just previous to starting the pump.

Microscopical Examination.

	1888. March.	1888. April.	1888. May.
1. Blue-green Algæ,	0.0	0.0	0.0
2. Other Algæ,	pr.	pr.	pr.
3. Fungi,	0.0	0.0	0.0
4. Animal Forms,	0.0	0.0	0.0

Groups and principal genera of organisms observed: 2. Palmellaceæ; Diatomaceæ.

Chemical Examination of Water from Little Pond in Braintree.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
2537	May 28	May 31	Slight.	Very slight.	0.45	4.10	1.30	2.80	.0020	.0228	.61	.0020	.0001

Hardness, 1.4. Odor, very faint or none. —— The sample was collected from Little Pond at the surface near the pumping station of the Braintree Water Supply Company.

Microscopical Examination.

May, 1888. An insignificant number of algæ present. Groups and principal genera of organisms observed: 2. Palmellaceæ; Zoosporeæ; Diatomaceæ.

Brewster.

Chemical Examination of Water from Long Pond in Brewster.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
2984	Aug. 18	Aug. 20	Distinct.	Slight.	0.0	4.95	1.25	3.70	.0012	.0228 .0194	1.44	.0020	.0001

Odor, very faint or none. —— The sample was collected from the pond.

Microscopical Examination.

August, 1888. 1. Blue-green algæ, pr.; 2. Other algæ, 16.2; 3. Fungi, 0.0; 4. Animal Forms, 0.1.

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Melosira*, *Stephanodiscus*. 4. Protozoa; Annelida; Rotifera; Entomostraca.

Water Supply of Bridgewater and East Bridgewater.— Bridgewaters Water Company.

Description of Works.— Population in 1885 : Bridgewater, 3,827 ; East Bridgewater, 2,812 ; total, 6,639. The works are owned by the Bridgewaters Water Company. Water was introduced in 1888. The average daily consumption in the summer of 1889 was about 75,000 gallons. The sources of supply are three wells on the east bank of the Town River in Bridgewater. The largest well is 60 feet in length, 25 feet in width and 17 feet in depth ; its shape is oval. The second well is a short distance from the first, and is cylindrical in shape, 22 feet in diameter and 22 feet in depth. Each of these wells is covered by a roof which excludes the light. The third well was built in May, 1889 ; it is 25 feet in diameter and 27 feet in depth ; its walls are of boiler iron. In the bottom of this well a tubular well 6 inches in diameter has been sunk to a farther depth of 86.5 feet. A small additional supply is obtained from a spring near by, which flows by gravity into the smallest well. The bottom of the largest well is about one foot below the ordinary level of the water in the river. The region about the wells and back of them is practically uninhabited. For a considerable distance back there is grass land ; farther back there is considerable woodland. Water from the wells is pumped to an open iron tank 22 feet in diameter and 75 feet high. Distributing mains are of cast iron. Service pipes are of wrought iron.

Chemical Examination of Water from the Wells of the Bridgewaters Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
2639	June 19	June 20	Distinct, milky.	Slight.	0.00	5.15	–	–	.0010	.0012	.50	.0800	.0001
2849	July 24	July 26	Distinct.	Slight, white.	0.10	4.75	–	–	.0000	.0017	.50	.0500	.0001
3012	Aug. 21	Aug. 22	Very slight	Very slight.	0.00	4.60	–	–	.0014	.0027	.48	.0030	.0001
3331	Oct. 8	Oct. 9	None.	None.	0.00	3.35	–	–	.0000	.0000	.44	.0080	.0000
3424	Oct. 23	Oct. 23	Very slight.	Very slight.	0.00	4.65	–	–	.0004	.0020	.32	.0300	.0000
3582	Nov. 21	Nov. 21	None.	None.	0.00	2.85	–	–	.0000	.0000	.44	.0090	.0000
3749	Dec. 19	Dec. 19	None.	None.	0.00	3.70	–	–	.0000	.0020	.46	.0120	.0000

Chemical Examination of Water from the Wells of the Bridgewaters Water Company — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
3889	Jan. 22	Jan. 23	Very slight.	None.	0.00	3.40	–	–	.0000	.0000	.46	.0220	.0000
4125	Feb. 26	Feb. 26	None.	None.	0.00	3.30	–	–	.0000	.0010	.47	.0400	.0001
4407	Mar. 27	Mar. 27	Distinct, milky.	None.	0.10	7.60	–	–	.0078	.0046	.54	.0400	.0002
4567	Apr. 24	Apr. 24	None.	None.	0.00	4.50	–	–	.0004	.0012	.49	.0500	.0000
4705	May 21	May 21	None.	None.	0.00	4.90	–	–	.0020	.0022	.51	.0300	.0000
Av.	....	....	....	....	0.02	4.20	–	–	.0011	.0016	.47	.0312	.0001

Odor, none. —— The samples were collected from a faucet at the pumping station while pumping, with the exception of No. 3012, which was collected while the pump was not in motion.

Microscopical Examination.

	1888. June	1888. July.	1888. Aug.	1888. Oct.	1888. Oct.	1888. Nov.	1888. Dec.	1889. Jan.	1889. Feb.	1889. Mar.	1889. Apr.	1889. May.
1. Blue-green Algæ, ...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	0.0	0.0	0.0	pr.	0.1	0.0	0.0	0.0	0.0	0.0	0.2	pr.
3. Fungi, ...	6.0	4.0	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
4. Animal Forms, ...	0.0	0.0	0.0	0.0	0.0	0.0	pr.	0.0	0.0	0.0	pr.	0.0

Groups and principal genera of organisms observed: 2. Diatomaceæ. 3. Schizomycetes, *Crenothrix*, *Leptothrix*. 4. Protozoa; Entomostraca.

Chemical Examination of Water from the Town River at Bridgewater.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
2638	June 19	June 20	Slight.	Slight.	3.20	6.40	3.45	2.95	.0016	.0452 .0400	.37	.0100	.0001
2847	July 24	July 26	Distinct.	Consid'ble.	1.30	9.30	2.20	7.10	.0032	.0392 .0252	.46	.0150	.0003
3011	Aug. 21	Aug. 22	Slight.	Slight.	0.80	4.85	1.70	3.15	.0008	.0254 .0224	.42	.0020	.0004
Av.	....	....	....	....	1.77	6.85	2.45	4.40	.0019	.0366 .0292	.42	.0090	.0003

Odor, faintly vegetable. —— The samples were collected from the river at the bridge about half a mile below the wells of the Bridgewaters Water Company and just above its confluence with the Matfield River.

Microscopical Examination.

	1888.		
	June.	July.	August.
1. Blue-green Algæ,	0.0	pr.	0.0
2. Other Algæ,	pr.	0.9	0.2
3. Fungi,	0.3	20.0	0.0
4. Animal Forms,	pr.	pr.	0.1

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ. 3. Schizomycetes, *Crenothrix*. 4. Protozoa; Spongiaria.

Water Supply of State Farm, Bridgewater.

This is a supply to a public institution which has a population averaging about 450. The works were built in 1885. The source of supply is the Taunton River near Dunbar's Bridge between Bridgewater and Middleborough and a short distance below the mouth of the Nemasket River. Water is pumped to an open iron tank 17 feet in diameter and 55 feet high. A supply of water for drinking purposes has at times been obtained from a spring. Distributing mains are of cast iron. Service pipes are of lead.

Chemical Examination of Water from the Taunton River at Bridgewater, a short distance below the confluence of the Taunton and Nemasket Rivers.

[Parts per 100,000.]

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.	Chlorine.	Nitrates.	Nitrites.
	1887.												
92	June 14	June 15	Decided.	Consid'ble.	5.00	6.57	3.27	3.30	.0011	.0414	.58	.0050	–
155	June 21	June 22	Slight.	None.	2.00	6.57	3.27	3.30	.0032	.0320	.42	.0000	–
536	Aug. 12	Aug. 12	Very slight.	None.	1.70	6.50	2.87	3.63	.0023	.0340	.51	.0030	–
810	Sept. 18	Sept. 19	Decided.	Slight.	1.40	5.80	1.85	3.95	.0013	.0241	.60	.0070	–
983	Oct. 18	Oct. 19	Slight.	Very slight.	1.00	5.25	1.15	4.10	.0008	.0216	.65	.0070	–
1230	Nov. 21	Nov. 21	Very slight.	Very slight.	1.10	6.30	2.45	3.85	.0013	.0285	.72	.0100	–
	1888.												
1659	Jan. 22	Jan. 23	Slight.	None.	1.10	6.15	2.20	3.95	.0024	.0242	.47	.0400	.0000
1867	Feb. 19	Feb. 20	Slight.	None.	1.00	5.60	2.00	3.60	.0035	.0271	.56	.0150	.0000
2068	Mar. 20	Mar. 21	Distinct.	Very slight.	1.00	4.45	1.65	2.80	.0004	.0226	.52	.0050	.0000
2282	Apr. 22	Apr. 23	Slight.	Very slight.	1.50	4.25	2.00	2.25	.0004	.0253	.46	.0200	.0002
2469	May 21	May 21	Very slight.	Very slight.	2.50	5.30	2.75	2.55	.0030	.0400	.40	.0080	.0001
2642	June 20	June 21	Very slight.	Very slight.	2.30				.0034	.0248	.46	.0100	.0003
						5.20	2.55	2.65					

Chemical Examination of Water from the Taunton River at Bridgewater, a short distance below the confluence of the Taunton and Nemasket Rivers — Con.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.	1888.											
2831	July 25	July 25	Very slight.	Very slight.	1.00	4.75	1.30	3.45	.0008	.0238 .0210	.51	.0150	.0001
2985	Aug. 20	Aug. 20	Slight.	Slight.	0.70	5.50	1.50	4.00	.0014	.0212	.61	.0050	.0003
3263	Sept. 25	Sept. 26	Very slight.	Very slight.	1.70	6.50	3.20	3.30	.0006	.0372 .0352	.51	.0080	.0002
3429	Oct. 23	Oct. 24	Very slight.	Very slight.	2.00	5.80	2.90	2.90	.0014	.0282 .0274	.51	.0050	.0002
3599	Nov. 22	Nov. 24	Very slight.	Slight.	2.40	5.25	2.95	2.30	.0004	.0280 .0276	.46	.0100	.0004
3768	Dec. 19	Dec. 21	Slight.	Very slight.	1.00	4.05	1.75	2.30	.0000	.0214 .0186	.47	.0090	.0002
	1889.	1889.											
3920	Jan. 23	Jan. 24	Very slight.	Very slight.	1.10	3.80	1.60	2.20	.0006	.0168 .0138	.43	.0070	.0003
4164	Feb. 27	Feb. 28	Very slight.	Very slight.	0.90	4.15	1.75	2.40	.0004	.0192 .0172	.47	.0090	.0003
4431	Mar. 28	Mar. 29	Very slight.	Very slight.	1.00	4.00	1.70	2.30	.0000	.0200 .0172	.53	.0070	.0001
4581	Apr. 25	Apr. 26	Very slight.	Very slight.	1.50	4.50	1.95	2.55	.0002	.0264 .0244	.44	.0050	.0002
4725	May 22	May 23	Very slight.	Slight.	2.40	5.40	2.85	2.55	.0032	.0298 .0274	.45	.0090	.0001
Av.	....	....	....	....	1.47	5.70	2.31	3.39	.0014	.0268	.51	.0095	.0002

Hardness in May, 1888, 1.1. Odor, faintly vegetable, seldom faintly mouldy. —— The samples were collected from a faucet in the office of the Superintendent of the State Farm.

Microscopical Examination.

	1888. June.	1888. July.	1888. Aug.	1888. Sept.	1888. Oct.	1888. Nov.	1888. Dec.	1889. Jan.	1889. Feb.	1889. Mar.	1889. Apr.	1889. May.
1. Blue-green Algæ, ...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	0.0	0.6	0.1	pr.	0.0	0.0	pr.	0.1	1.6	3.9	0.8	0.1
3. Fungi, ...	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, ...	0.0	0.2	0.0	0.0	0.0	0.0	pr.	0.0	0.4	0.2	0.0	pr.

Groups and principal genera of organisms observed: 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Asterionella*. 3. Schizomycetes. 4. Protozoa; Spongiaria.

Chemical Examination of Water from the Taunton River at Bridgewater, a short distance below the confluence of the Taunton and Nemasket Rivers.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
93	June 14	June 15	Very slight.	None.	4.00	6.42	2.80	3.62	.0025	.0393	.52	.0050	–
154	June 21	June 22	Very slight.	Slight.	1.80	5.30	2.35	2.95	.0024	.0322	.47	.0260	–
351	July 18	July 19	Very slight.	Very slight.	1.10	4.75	1.40	3.35	.0024	.0251	.48	.0040	–
535	Aug. 11	Aug. 12	Very slight.	Slight.	1.80	6.30	2.75	3.55	.0041	.0357	.44	.0000	–
Av.	....	....	....	....	1.57	5.69	2.33	3.36	.0029	.0331	.48	.0088	–

Odor, faintly vegetable, sometimes faintly mouldy.—— The samples were collected from the river at Dunbar's Bridge.

Chemical Examination of Water from a Spring at State Farm, Bridgewater.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
402	July 26	July 26	None.	None.	0.0	9.07	–	–	.0002	.0030	1.11	.3900	–
534	Aug. 11	Aug. 12	Very slight, milky.	None.	0.0	7.60	–	–	.0002	.0010	0.88	.2600	–

Odor, none.—— The samples were collected from a spring which has occasionally been used as a source of water supply for the State Farm.

Chemical Examination of Water from the Taunton River at Bridgewater just above its confluence with the Nemasket River.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
352	July 18	July 19	Very slight.	Very slight.	1.30	6.55	2.15	4.40	.0036	.0351	.57	.0070	–
809	Sept. 18	Sept. 19	Decided.	Very slight.	1.70	7.00	2.10	4.90	.0007	.0342	.69	.0070	–
981	Oct. 18	Oct. 19	Distinct.	Slight.	1.50	6.55	1.60	4.95	.0014	.0306	.72	.0130	–
1232	Nov. 21	Nov. 21	Distinct.	Slight.	1.40	7.50	3.45	4.05	.0021	.0358	.69	.0080	–
1448	Dec. 19	Dec. 21	Decided.	Slight, earthy.	1.50	7.45	3.25	4.20	.0034	.0336	.70	.0120	–

Chemical Examination of Water from the Taunton River at Bridgewater, just above its confluence with the Nemasket River — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.	1888.											
1658	Jan. 22	Jan. 23	Slight.	Slight.	1.80	7.25	3.15	4.10	.0007	.0284	.51	.0250	.0000
1865	Feb. 19	Feb. 20	Slight.	None.	1.30	6.50	3.00	3.50	.0039	.0294	.60	.0200	.0000
2066	Mar. 20	Mar. 21	Distinct.	Slight.	1.10	4.85	2.10	2.75	.0005	.0230	.50	.0100	.0000
2280	Apr. 22	Apr. 23	Very slight.	Slight.	2.30	5.10	2.45	2.65	.0004	.0312	.51	.0200	.0001
2471	May 21	May 21	Very slight.	Very slight.	2.80	5.85	3.25	2.60	.0016	.0412	.38	.0120	.0001
2640	June 20	June 21	Slight.	Very slight.	–	6.95	3.45	3.50	.0030	.0378 .0360	.53	.0080	.0001
2832	July 25	July 25	Very slight.	Slight.	0.90	4.80	1.45	3.35	.0010	.0214 .0198	.50	.0070	.0001
2987	Aug. 20	Aug. 20	Slight.	Slight.	1.10	6.00	2.00	4.00	.0008	.0276 .0228	.61	.0080	.0003
3262	Sept. 25	Sept. 26	Very slight	Very slight.	2.80	7.90	4.25	3.65	.0008	.0404	.52	.0100	.0002
3428	Oct. 23	Oct. 24	Very slight.	Very slight.	3.70	6.75	3.75	3.00	.0012	.0396 .0370	.57	.0070	.0002
3597	Nov. 22	Nov. 24	Very slight.	Slight.	3.00	6.15	3.35	2.80	.0002	.0342 .0300	.47	.0100	.0004
3770	Dec. 19	Dec. 21	Distinct.	Slight, earthy.	0.90	4.00	1.65	2.35	.0000	.0218 .0200	.45	.0080	.0001
	1889.	1889.											
3919	Jan. 23	Jan. 24	Slight.	Slight.	1.80	3.95	1.75	2.20	.0002	.0164 .0144	.45	.0050	.0002
4163	Feb. 27	Feb. 28	Very slight.	Very slight.	0.60	4.70	1.90	2.80	.0014	.0208 .0202	.49	.0120	.0003
4430	Mar. 28	Mar. 29	Slight.	Slight.	1.30	4.25	1.45	2.80	.0000	.0238 .0212	.52	.0090	.0002
4580	Apr. 25	Apr. 26	Very slight.	Slight.	2.40	5.35	2.70	2.65	.0004	.0374 .0310	.50	.0070	.0001
4724	May 22	May 23	Distinct.	H'vy, br'n.	2.80	6.25	3.15	3.10	.0036	.0356 .0350	.49	.0180	.0000
Av..	....	....	....	....	1.81	6.46	2.65	3.81	.0014	.0309	.54	.0110	.0001

Hardness in May, 1888, 1.1. Odor, vegetable, occasionally faintly mouldy.——The samples were collected from the river at Sturtevant's Bridge.

Microscopical Examination.

	1888. June.	1888. July.	1888. Aug.	1888. Sept.	1888. Oct.	1888. Nov.	1888. Dec.	1889. Jan.	1889. Feb.	1889. Mar.	1889. April.	1889. May.
1. Blue-green Algæ, .	pr.	pr.	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, . .	pr.	pr.	0.1	0.2	pr.	0.2	0.2	0.0	0.5	0.9	1.4	0.1
3. Fungi, . . .	4.0	0.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, . .	pr.	pr.	pr.	pr.	0.0	0.0	pr.	0.0	0.0	0.2	0.0	pr.

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ; Zygnemaceæ. 3. Schizomycetes, *Crenothrix*. 4. Protozoa; Spongiaria; Rotifera; Entomostraca.

Water Supply of Brockton.

Description of Works.—Population in 1885, 20,783. The works are owned by the city. Water was introduced in 1880. The average daily consumption in 1888 is estimated to have been about 1,000,000 gallons. The source of supply is a storage reservoir on Salisbury Brook, in Avon, near the boundary line between Avon and Brockton. Area of reservoir, about 100 acres; maximum depth, 18 feet; capacity, 330,000,000 gallons. The bottom of the reservoir slopes somewhat regularly from the upper end toward the dam. The average depth is not great, but there is not much very shallow flowage in the reservoir proper. When the water is high, however, the lower end of a large meadow at the upper end of the reservoir is flowed to a small depth. A portion of this meadow, adjoining the reservoir, is partially isolated from it by dikes built in 1887. The drainage area, of 3.12 square miles, contains but a small population. On the borders of the drainage area, the land is generally rocky and covered with wood, and the slopes are very abrupt. In the middle of the area there is a large amount of meadow and swamp land, over the surface of which the water slowly finds its way to the channel which conveys it to the reservoir. For the purpose of obtaining filtered water, 4-inch tile drains were laid beneath the bottom of the reservoir before it was filled. The drains are 30 inches beneath the surface and 8 feet apart, and are connected with a conduit from which the water can be drawn into the main supply pipe to the city. An area of about 65,000 square feet was prepared in this way, but the filter has never been used except to test it, as the water from it causes complaint as soon as it is turned on. Water is distributed by gravity. Distributing mains are of cast iron, with the exception of the main pipe from the reservoir to the city, which is of wrought iron lined with cement. Service pipes are of wrought iron lined with cement.

A bad taste and odor have been observed in the water of the reservoir during the summer and fall of several years. This first occurred in 1881, while water was being drawn from the bottom of the reservoir. The intake was then changed to a point near the surface, and complaint of the taste and odor ceased for the time. It is said that the trouble was not serious again until 1885, but it has occurred every year since this date. The character of this water and the causes of the tastes and odors, will be discussed in a subsequent portion of this report.

Chemical Examination of Water from Salisbury Brook at the point where it enters the Storage Reservoir.

[Parts per 100,000]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
4659	May 13	May 14	Very slight.	Very slight.	2.4	5.75	3.35	2.40	.0022	.0468 .0432	.30	.0020	.0001
4742	May 25	May 28	Very slight.	None.	2.8	–	–	–	.0008	.0390 .0362	.25	.0020	.0006

Odor, faintly vegetable.——The samples were collected from the brook just before it enters the reservoir.

Microscopical Examination.

May 13, 1889. 1. Blue-green algæ, pr.; 2. Other algæ, pr.; 3. Fungi, 0.0; 4. Animal Forms, 0.2. May 25, 1889, No organisms. Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Diatomaceæ. 4. Protozoa.

Chemical Examination of Water from Salisbury Brook Storage Reservoir.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
206	June 27	June 28	Decided.	Slight.	1.20	4.42	1.57	2.85	.0010	.0394	.30	.0060	–
422	July 27	July 28	Decided.	Very much.	1.20	4.32	1.70	2.62	.0016	.0370	.29	.0040	–
736	Sept. 12	Sept. 13	Decided.	Consid'ble	1.00	5.80	2.92	2.88	.0017	.0858	.33	.0030	–
842	Sept. 22	Sept. 23	Decided.	Consid'ble.	0.90	5.95	2.95	3.00	.0009	.0978	.30	.0030	–
1050	Oct. 26	Oct. 27	Decided.	Considerable.	0.80	4.50	2.15	2.35	.0068	.0518 .0282	.37	.0080	–
1237	Nov. 21	Nov. 22	Slight.	Sli't, white.	1.00	4.45	2.15	2.30	.0062	.0345	.37	.0140	–
1464	Dec. 21	Dec. 22	Decided.	Considerable.	0.80	5.15	2.30	2.85	.0046	.0327	.38	.0100	.0000
	1888.												
1663	Jan. 23	Jan. 24	Slight.	Slight.	0.60	4.35	2.00	2.35	.0047	.0315	.30	.0100	.0000
1856	Feb. 17	Feb. 18	Slight.	Sli't, white.	1.00	4.70	1.85	2.85	.0085	.0316	.39	.0100	.0000
2041	Mar. 19	Mar. 20	Slight.	Slight.	0.70	3.70	1.25	2.45	.0000	.0248	.34	.0070	.0001
2269	Apr. 20	Apr. 21	Distinct.	Slight.	0.45	2.75	0.95	1.80	.0005	.0231	.31	.0080	.0002
2459	May 18	May 19	Decided.	Consid'ble.	0.70	3.30	1.40	1.90	.0000	.0356	.27	.0050	.0001
2626	June 18	June 19	Distinct.	Considerable.	0.90	3.50	1.65	1.85	.0010	.0310 .0234	.28	.0050	.0000
2820	July 23	July 24	Distinct.	Slight, green.	0.90	3.60	1.35	2.25	.0004	.0462 .0260	.29	.0030	.0001
2992	Aug. 20	Aug. 21	Distinct.	Considerable.	0.70	4.20	1.65	2.55	.0008	.0726 .0310	.27	.0050	.0002

Chemical Examination of Water from Salisbury Brook Storage Reservoir — Con.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
3031	Aug. 24	Aug. 25	Decided.	Considerable, green.	0.80	3.80	2.20	1.60	.0006	.0670 .0296	.22	.0020	.0000
3129	Sept. 7	Sept. 10	Distinct.	Considerable, green.	0.60	3.70	1.70	2.00	.0024	.0700 .0332	.24	.0020	.0001
3138	Sept. 8	Sept. 10	Distinct.	Slight.	0.65	3.65	1.90	1.75	.0038	.0660 .0304	.25	.0000	.0002
3249	Sept. 24	Sept. 25	Distinct.	Considerable, green.	0.60	3.70	1.90	1.80	.0084	.0624 .0294	.29	.0060	.0002
3324	Oct. 8	Oct. 9	Distinct.	Considerable, green.	0.80	4.30 4.10	1.95 1.80	2.35 2.30	.0046	.0348 .0260	.27	.0090	.0002
3417	Oct. 22	Oct. 23	Distinct.	Slight.	1.10	4.15	2.05	2.10	.0112	.0332 .0262	.31	.0080	.0003
3578	Nov. 20	Nov. 21	Slight.	Con., earthy.	0.90	4.00	1.75	2.25	.0060	.0314 .0286	.31	.0100	.0002
3729	Dec. 17	Dec. 18	Very slight.	Very slight.	0.60	3.45	1.40	2.05	.0024	.0178 .0164	.39	.0070	.0000
	1889.												
3886	Jan. 21	Jan. 22	Slight.	Very slight.	0.40	2.75	0.90	1.85	.0002	.0152 .0124	.30	.0060	.0000
4123	Feb. 25	Feb. 26	Very slight.	Slight.	0.45	2.95	1.10	1.85	.0002	.0136 .0114	.29	.0050	.0003
4395	Mar. 26	Mar. 27	Slight.	Very slight.	0.40	2.60	0.80	1.80	.0004	.0186 .0158	.30	.0050	.0001
4559	Apr. 23	Apr. 24	Distinct.	Considerable.	0.45	2.80	1.00	1.80	.0000	.0220 .0142	.31	.0020	.0002
4660	May 13	May 14	Distinct.	Slight.	0.55	2.85	1.25	1.60	.0016	.0270 .0200	.32	.0020	.0002
4743	May 25	May 28	Decided.	Con., light green.	0.60	–	–	–	.0008	.0370 .0224	.34	.0040	.0005
Av.	....	....	....	....	0.75	4.44	1.93	2.51	.0028	.0411	.31	.0058	.0001

Hardness in May, 1888, 0.5. Odor generally vegetable and grassy, sometimes mouldy.—— Samples 206 to 2626 were collected from the reservoir near the gate-house 5 feet beneath the surface. All others were collected at a depth of 6 inches to 2 feet beneath the surface. Samples 4123 to 4743 were collected 40 to 50 feet from shore.

Microscopical Examination.

	1888. June.	1888. July.	1888. Aug.	1888. Aug.	1888. Sept.	1888. Oct.	1888. Oct.	1888. Nov.	1888. Dec.	1889. Jan.	1889. Feb.	1889. Mar.	1889. Apr.	1889. May.	1889. May.
1. Blue-green Algæ,	pr.	20.5	4.3	2.6	–	2.0	0.2	pr.	0.0	0.0	0.0	0.0	pr.	pr.	0.0
2. Other Algæ, .	11.6	3.0	0.9	2.3	–	0.5	1.6	11.3	0.6	1.1	0.2	1.1	4.2	pr.	2.0
3. Fungi, . . .	0.0	0.0	0.0	0.0	–	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, .	0.4	pr.	0.1	0.7	–	0.9	pr.	0.3	0.0	0.0	1.0	8.1	0.1	0.2	1.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ, *Anabæna*, *Clathrocystis* 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Asterionella*, *Melosira*, *Tabellaria;* Zygnemaceæ. 4. Protozoa; Spongiaria; Rotifera; Entomostraca.

Chemical Examination of Water from Salisbury Brook Storage Reservoir, collected 15 feet beneath the surface.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
4744	May 25	May 28	Decided.	Consid'ble, light green.	0.65	–	–	–	.0024	.0358 .0228	.33	.0030	.0005

Odor, very faintly vegetable. —— The sample was collected from the reservoir about 40 feet from shore and 15 feet beneath the surface. The total depth of the reservoir at this point is about 18 feet at high water.

Microscopical Examination.

May, 1889. 1. Blue-green algæ, pr.; 2. Other algæ, 1.1. Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Diatomaceæ.

Chemical Examination of Water from a faucet at City Hall, Brockton.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
207	June 27	June 28	Slight.	Slight.	1.10	4.80	1.70	3.10	.0020	.0331	.30	.0060	–
423	July 27	July 28	Decided.	Very slight.	1.20	4.75	1.85	2.90	.0015	.0475	.31	.0130	–
737	Sept. 12	Sept. 13	Decided.	Con., green.	1.20	6.15	2.82	3.33	.0036	.0789	.33	.0230	–
841	Sept. 22	Sept. 23	Decided.	Consid'ble.	1.00	5.45	2.40	3.05	.0144	.0671	.32	.0090	–
1051	Oct. 26	Oct. 27	Decided.	Slight.	0.75	4.60	2.20	2.40	.0032	.0366 .0344	.36	.0200	–
1238	Nov. 21	Nov. 22	Distinct.	Slight.	1.00	4.60	1.90	2.70	.0030	.0320	.39	.0180	–
1465	Dec. 21	Dec. 22	Decided.	Considerable.	1.30	5.95	2.25	3.70	.0032	.0448	.39	.0130	.0000
	1888.												
1664	Jan. 23	Jan. 24	Slight.	Very slight.	0.60	4.70	1.90	2.80	.0020	.0245	.30	.0200	.0001
1857	Feb. 17	Feb. 18	Very slight.	Very slight.	1.10	5.00	1.85	3.15	.0033	.0279	.41	.0150	.0000
2042	Mar. 19	Mar. 20	Slight.	Slight.	0.60	3.75	1.35	2.40	.0004	.0186	.34	.0070	.0001
2270	Apr. 20	Apr. 21	Slight.	Slight.	0.45	2.65	0.85	1.80	.0012	.0204	.29	.0120	.0001
2460	May 18	May 19	Distinct.	Consid'ble.	0.60	3.85	2.15	1.70	.0010	.0312	.28	.0060	.0001
2627	June 18	June 19	Very slight.	Slight.	1.20	3.90	1.60	2.30	.0004	.0248 .0210	.25	.0070	.0001
2821	July 23	July 24	Decided.	Slight.	0.90	3.80	1.60	2.20	.0048	.0312 .0294	.28	.0150	.0003
2993	Aug. 20	Aug. 21	Distinct.	Slight.	0.60	4.45	1.60	2.85	.0082	.0382 .0284	.27	.0200	.0004
3250	Sept. 24	Sept. 25	Slight.	Slight, green.	0.40	4.25	1.80	2.45	.0036	.0446 .0294	.29	.0200	.0002

Chemical Examination of Water from a Faucet at City Hall, Brockton — Con.

Number.	Date of Collection.	Date of Examination.	Appearance: Turbidity.	Appearance: Sediment.	Appearance: Color.	Residue on Evaporation: Total.	Residue on Evaporation: Loss on Ignition.	Residue on Evaporation: Fixed.	Ammonia: Free.	Ammonia: Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
3418	Oct. 22	Oct. 23	Distinct.	Slight.	1.00	4.35	1.80	2.55	.0034	.0306 .0266	.31	.0090	.0003
3579	Nov. 20	Nov. 21	Slight.	Very slight.	1.30	3.90	1.60	2.30	.0008	.0274 .0248	.29	.0150	.0002
3730	Dec. 17	Dec. 18	Slight.	Considerable, black.	0.60	3.20	1.20	2.00	.0000	.0164 .0142	.39	.0080	.0001
	1889.												
3887	Jan. 21	Jan. 22	Very slight.	Slight.	0.50	2.80	1.05	1.75	.0010	.0126 .0114	.30	.0050	.0001
4124	Feb. 25	Feb. 26	Distinct.	Much, reddish brown.	0.45	3.35	1.05	2.30	.0002	.0146 .0104	.31	.0070	.0001
4396	Mar. 26	Mar. 27	Distinct.	Slight.	0.45	2.95	0.75	2.20	.0006	.0206 .0148	.30	.0080	.0001
4560	Apr. 23	Apr. 24	Slight.	Slight, rusty.	0.50	2.90	0.95	1.95	.0004	.0220 .0176	.32	.0040	.0002
4661	May 13	May 14	Very slight.	None.	0.45	3.30	1.35	1.95	.0018	.0190 .0178	.31	.0060	.0004
Av.	....	....	....	....	0.80	4.69	1.94	2.75	.0027	.0319	.32	.0119	.0002

Hardness in May, 1888, 1.4. Odor, generally faintly grassy and vegetable, seldom mouldy. —— The samples were collected from a faucet in City Hall at about the centre of distribution and 2½ miles from the reservoir.

Microscopical Examination.

	1888. June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	1889. Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ, ...	pr.	0.2	0.9	0.2	0.1	pr.	0.0	0.0	pr.	0.0	0.0	0.0
2. Other Algæ, ...	2.1	0.9	0.8	pr.	5.1	3.3	pr.	0.3	1.5	2.2	2.4	0.0
3. Fungi, ...	0.0	80.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, ...	pr.	pr.	0.1	0.0	pr.	pr.	0.0	0.0	1.0	2.0	0.1	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Melosira;* Zygnemaceæ. 3. Schizomycetes, *Crenothrix.* 4. Protozoa, *Dinobryon;* Rotifera; Entomostraca.

Chemical Examination of Sample from Center Street Drain, Brockton.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance: Turbidity.	Appearance: Sediment.	Appearance: Color.	Residue on Evaporation: Total.	Residue on Evaporation: Loss on Ignition.	Residue on Evaporation: Fixed.	Ammonia: Free.	Ammonia: Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
2794	July 18	July 19	Very decided.	Much rusty.	–	60.30 55.40	10.90 10.60	49.40 44.80	.9200	.0400 .0300	8.98	.4000	.0120

Odor, mouldy.——The sample was collected from the Center Street Drain at a manhole at the corner of Bay Street, and represents the dry-weather flow of the drain, no rain having fallen for over a week and the depth of flow being but about 1½ inches.

Microscopical Examination.

July, 1888. 3. Fungi (Schizomycetes), 0.6.

Chemical Examination of Water from Factory Pond, Brockton.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance: Turbidity.	Appearance: Sediment.	Appearance: Color.	Residue on Evaporation: Total.	Residue on Evaporation: Loss on Ignition.	Residue on Evaporation: Fixed.	Ammonia: Free.	Ammonia: Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
3486	Oct. 31	Nov. 1	Slight.	Slight	1.3	5.90	1.90	4.00	.0084	.0244 .0198	.84	.0500	.0012
	1889.												
4195	Mar. 4	Mar. 4	Slight.	Very slight.	0.2	5.20	1.35	3.85	.0166	.0162 .0128	.81	.1000	.0010

Odor, earthy.——The samples were collected from the pond opposite the ice-house.

Water Supply of Brookfield.

Description of Works.—Population in 1885, 3,013. The works are owned by the town of Brookfield. Water was introduced in 1889 for fire purposes, but it is now used to a slight extent for domestic purposes also. The source of supply is a small storage reservoir located near the boundary line between Brookfield and North Brookfield. Its area is about 1¼ acres, in addition to which there is a considerable area flowed to a slight depth at high water. The maximum depth of the reservoir is 17 feet, and the bottom is of clay and gravel. The drainage area of about 70 acres is uninhabited and consists mainly of cultivated and pasture land; there is a small area of woodland. Distributing mains are of cast iron.

Chemical Examination of Water from Brookfield Storage Reservoir.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
4858	June 19	June 20	Distinct.	Considerable.	1.2	–	–	–	.0018	.0630 .0508	.18	.0030	–
4859	June 19	June 20	Distinct.	Heavy.	1.4	–	–	–	.0206	.0526 .0386	.24	.0030	–

Odor of No. 4858, distinctly vegetable; of No. 4859, disagreeable.—— No. 4858 was collected from the reservoir. No. 4859 was collected from a faucet in the village of Brookfield.

Water Supply of Brookline.

Description of Works. — Population in 1885, 9,196. The works are owned by the town. Water was introduced in 1875; the average daily consumption in 1888 was 835,000 gallons. The source of supply is a filter-gallery on the right bank of Charles River at West Roxbury. The gallery is built in three sections. The first section is 491 feet long, the second 271 feet and the third 300 feet. The first and second sections of the gallery are connected by a pipe conduit 389 feet in length, and the third section is practically an extension of the second, differing from it in size and manner of construction. The first two sections are 4 feet wide with side walls 2 feet high of stone laid dry. The arch is of brick laid in cement. The third section is larger than the others, being 6 feet wide and 6 feet high, with side walls laid in cement and arched like the others. A ditch has been dug from the river alongside the second section of the gallery, and when necessary this ditch is filled with water from the river to increase the amount filtering into the gallery. A direct connection has also been built between this ditch and the gallery in order that river water may be taken direct if necessary. This connection is said to have been used but once. The bottom of the gallery is 6 feet below the river in its lowest stage. Pumps force the water from the filter-gallery to an open distributing reservoir. The shape of this reservoir is an irregular oval. Its depth when filled to high-water mark is 20 feet, and its corresponding capacity 6,050,000 gallons. The slopes and bottom are lined with clay puddle, the

layer on the slopes having a thickness of 18 inches and that on the bottom 12 inches. The bottom puddle is covered with a layer of concrete 4 inches in thickness, and the slopes with 12 inches of broken stone upon which is laid a dry slope wall of stone. The water enters the reservoir at one end and is drawn from it at the same place. At a point on the main pipe about half way between the source of supply and the reservoir a second pump is located, which forces water from the main to an iron tank, 30 feet high and 50 feet in diameter, used for high-service distribution. The tank was originally open at the top, but was covered to exclude light Aug. 11, 1887. Distributing mains are of cast iron, service pipes are generally of wrought iron lined with cement, though lead is also used. There are also a few of enameled iron, which was used at the time the works were built.

The water when pumped from the filter-gallery has always been free from odor and taste; but, after standing in the reservoir, and in the high-service tank before it was covered, it acquired a disagreeable taste and odor. Since the high-service tank was covered, the water in it has not deteriorated. In 1879, in order to secure circulation in the distributing reservoir and thereby prevent the recurrence of the disagreeable taste and odor, the inlet pipe was extended around the reservoir to a point opposite the gate-house; and, after thoroughly cleaning the reservoir, practically all the water used for the supply of the town was passed through it, entering at one end and flowing out from the opposite end. The amount of water in the reservoir at this time was usually not over a day's supply for the town, and as a consequence most of the water was changed every day. It was soon found, however, that the quality of the water was not appreciably improved by this arrangement, and it was given up. At present the water in the low-service reservoir is changed as little as possible, water being pumped at about the same rate as it is used. From April 1 to December 1 the pumps are run from 6 A.M. to 10 P.M. During the remaining four months the pumps are run twelve hours per day, which is found to be sufficient to prevent complaints at that season of the year.

Chemical Examination of Water from the Filter-Gallery of the Brookline Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Exam-ination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albu-minoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
42	June 6	June 7	None.	Very slight.	0.00	7.90	–	–	.0002	.0018	.58	.0320	–
254	July 6	July 6	None.	None.	0.00	6.65	–	–	.0006	.0049	.56	.0200	–
495	Aug. 8	Aug. 8	None.	None.	0.00	6.65	–	–	.0010	.0055	.53	.0260	–
712	Sept. 8	Sept. 9	None.	None.	0.00	7.30	–	–	.0004	.0017	.56	.0260	–
914	Oct. 10	Oct. 11	None.	None.	0.00	7.05	–	–	.0008	.0016	.52	.0260	–
1120	Nov. 8	Nov. 9	None.	None.	0.00	7.15	–	–	.0000	.0018	.53	.0230	–
1354	Dec. 8	Dec. 9	Very slight.	None.	0.00	7.35	–	–	.0000	.0021	.57	.0300	–
	1888.												
1558	Jan. 9	Jan. 10	None.	None.	0.00	7.45	–	–	.0000	.0044	.55	.0700	.0000
1768	Feb. 7	Feb. 8	None.	None.	0.00	7.15	–	–	.0000	.0010	.51	.0250	.0000
1969	Mar. 7	Mar. 8	None.	None.	0.05	7.10	–	–	.0004	.0028	.51	.0400	.0001
2179	Apr. 10	Apr. 11	None.	None.	0.20	6.15	–	–	.0000	.0092	.46	.0250	.0001
2372	May 8	May 9	None.	None.	0.00	6.80	–	–	.0000	.0042	.53	.0280	.0000
2558	June 6	June 7	None.	None.	0.00	7.05	–	–	.0006	.0048	.56	.0400	.0001
2708	July 4	July 5	None.	None.	0.00	6.55	–	–	.0000	.0046	.50	.0300	.0000
2892	Aug. 7	Aug. 8	None.	None.	0.00	6.80	–	–	.0000	.0042	.52	.0280	.0000
3344	Oct. 10	Oct. 11	None.	None.	0.00	6.95	–	–	.0016	.0062	.56	.0200	.0001
3448	Oct. 25	Oct. 26	None.	Very slight.	0.00	7.00	–	–	.0000	.0056	.53	.0280	.0000
3504	Nov. 7	Nov. 8	None.	None.	0.00	6.85	–	–	.0000	.0030	.55	.0240	.0000
3658	Dec. 5	Dec. 6	None.	None.	0.20	5.50	–	–	.0000	.0100	.44	.0250	.0002
	1889.												
3899	Jan. 22	Jan. 23	None.	None.	0.10	5.65	–	–	.0000	.0062	.46	.0200	.0001
3977	Feb. 6	Feb. 7	Very slight.	None.	0.00	6.10	–	–	.0002	.0058	.51	.0380	.0001
4055	Feb 20	Feb. 21	None.	None.	0.00	6.25	–	–	.0002	.0022	.53	.0280	.0000
4238	Mar. 7	Mar. 8	None.	None.	0.05	6.40	–	–	.0000	.0034	.56	.0400	.0000
4499	Apr. 11	Apr. 12	Very slight.	Sli't, brown.	0.00	6.90	–	–	.0000	.0032	.59	.0250	.0000
4633	May 8	May 9	None.	None.	0.00	7.10	–	–	.0014	.0026	.58	.0040	.0000
Av.	....	....	....	....	0.03	6.79	–	–	.0003	.0041	.53	.0299	.0000

Hardness in May, 1888, 3.6. Odor, none.—— The samples were collected from a faucet at the pumping station while pumping.

Microscopical Examination.

	1888.									1889.					
	Apr.	May.	June.	July.	Aug.	Oct.	Oct.	Nov.	Dec.	Jan.	Feb.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ,	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, .	0.0	0.0	0.0	0.0	0.0	pr.	0.0	0.0	0.0	0.0	0.0	pr.	pr.	pr.	pr.
3. Fungi, . . .	0.0	0.0	0.0	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
4. Animal Forms, .	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Groups and principal genera of organisms observed: 2. Zoosporeæ; Diatomaceæ. 3. Schizomycetes.

Chemical Examination of Water from the Distributing Reservoir of the Brookline Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
58	June 8	June 9	Milky.	None.	0.10	6.80	–	–	.0010	.0190	.44	.0260	–
255	July 6	July 6	Slight.	None.	0.00	6.62	–	–	.0002	.0125	.56	.0000	–
496	Aug. 8	Aug. 8	Very slight.	None.	0.00	6.70	–	–	.0003	.0114	.51	.0000	–
713	Sept. 8	Sept. 9	Distinct.	Slight.	0.00	6.92	–	–	.0005	.0124	.53	.0030	–
915	Oct. 10	Oct. 11	Distinct.	Very slight.	0.05	7.10	–	–	.0007	.0148	.52	.0000	–
1122	Nov. 8	Nov. 9	Decided.	Considerable, white.	0.00	7.25	–	–	.0000	.0182	.53	.0030	–
1356	Dec. 8	Dec. 9	Very slight.	None.	0.00	7.30	–	–	.0000	.0054	.58	.0280	–
	1888.												
1559	Jan. 9	Jan. 10	Slight.	Very slight.	0.00	7.35	–	–	.0005	.0136	.58	.0300	.0001
1767	Feb. 7	Feb. 8	Slight.	Very slight.	0.00	7.10	–	–	.0000	.0104	.54	.0250	.0003
1967	Mar. 7	Mar. 8	Distinct.	Considerable, earthy.	0.10	7.55	–	–	.0004	.0167	.53	.0150	.0003
2181	Apr. 10	Apr. 11	Decided.	Very slight, white.	0.20	6.00	–	–	.0000	.0211	.48	.0050	.0002
2373	May 8	May 9	Decided, green.	Sli't, green.	0.05	6.80	–	–	.0002	.0262 .0120	.52	.0050	.0001
2559	June 6	June 7	Slight.	Considerable, white.	0.00	7.90	–	–	.0022	.0172 .0114	.51	.0040	.0002
2707	July 4	July 5	Distinct.	Slight, white.	0.00	7.45	–	–	.0000	.0104 .0096	.52	.0030	.0000
2893	Aug. 7	Aug. 8	Distinct.	Very slight.	0.00	6.75	–	–	.0000	.0160 .0110	.48	.0000	.0000
3346	Oct. 10	Oct. 11	Distinct.	Considerable, white.	0.00	6.70	–	–	.0002	.0112 .0096	.51	.0060	.0000

Chemical Examination of Water from the Distributing Reservoir of the Brookline Water Works — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
3449	Oct. 25	Oct. 26	Slight.	Considerable, green.	0.00	7.35 7.10	–	–	.0004	.0186 .0108	.51	.0070	.0000
3505	Nov. 7	Nov. 8	Distinct.	Heavy, light green.	0.00	7.15 6.80	–	–	.0000	.0176 .0114	.50	.0070	.0001
3656	Dec. 5	Dec. 6	Distinct.	Slight, white.	0.05	6.75 6.35	–	–	.0002	.0204 .0100	.49	.0120	.0003
	1889.												
3900	Jan. 22	Jan. 23	Slight.	Slight. white.	0.05	6.15	–	–	.0000	.0182 .0126	.47	.0120	.0004
3979	Feb. 6	Feb. 7	Distinct.	Slight, white.	0.02	4.70 4.55	–	–	.0008	.0156 .0062	.37	.0120	.0003
4056	Feb. 20	Feb. 21	Distinct.	Slight, green.	0.00	5.95 5.55	–	–	.0008	.0160 .0060	.43	.0120	.0005
4239	Mar. 7	Mar. 8	Distinct.	Con., light green.	0.05	6.50 6.00	–	–	.0000	.0218 .0074	.55	.0100	.0002
4500	Apr. 11	Apr. 12	Very slight.	Very slight.	0.03	6.95	–	–	.0000	.0080 .0062	.55	.0220	.0001
4634	May 8	May 9	Distinct.	Con., light green.	0.00	7.50	–	–	.0002	.0206 .0094	.55	.0030	.0001
Av.	....	....	....	....	0.03	6.78	–	–	.0003	.0157	.51	.0100	.0002

Hardness in June, 1887, 3.4; in May, 1888, 4.2. Odor, vegetable and disagreeable.—— The samples were collected from the reservoir. The reservoir had been drawn down ten feet when No. 1122 was collected. It was entirely emptied, cleaned and refilled before 1356 was collected. The reservoir was also drawn off and cleaned July 18, 1888, and April 10, 1889.

Microscopical Examination.

	1888. June.	1888. July.	1888. Aug.	1888. Oct.	1888. Oct.	1888. Nov.	1888. Dec.	1889. Jan.	1889. Feb.	1889. Feb.	1889. Mar.	1889. Apr.	1889. May.
1. Blue-green Algæ,	–	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, .	73.0	250.3	20.2	32.3	316.2	801.8	2598.8	6.0	90.6	654.0	1004.3	2.6	205.0
3. Fungi, . .	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, .	pr.	pr.	pr.	0.4	pr.	0.0	0.0	0.0	8.3	0.8	0.4	0.0	0.5

Groups and principal genera of organisms observed: 2. Palmellaceæ, *Chlorococcus*, *Protococcus*; Zoosporeæ, *Pandorina*, *Raphidium*, *Scenedesmus*, *Tetraspora*; Desmidiaceæ; Diatomaceæ, *Asterionella*, *Stephanodiscus*, *Synedra*; Volvocineæ, *Volvox*. 4. Protozoa, *Dinobryon*, *Peridinium*; Rotifera; Entomostraca.

Chemical Examination of Water from the High Service Tank of the Brookline Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
256	July 5	July 7	Very slight.	Slight, rusty.	0.00	6.72	–	–	.0000	.0054	.55	.0200	–
714	Sept. 8	Sept. 9	Very slight.	Slight.	0.00	7.32	–	–	.0000	.0020	.57	.0200	–
916	Oct. 10	Oct. 11	None.	None.	0.00	7.40	–	–	.0000	.0021	.55	.0330	–
1121	Nov. 8	Nov. 9	None.	Very slight.	0.00	6.95	–	–	.0000	.0019	.56	.0300	–
1355	Dec. 8	Dec. 9	None.	None.	0.00	7.30	–	–	.0000	.0024	.61	0300	–
	1888.												
1560	Jan. 9	Jan. 10	None.	None.	0.00	7.25	–	–	.0000	.0008	.56	.0450	.0001
1766	Feb. 7	Feb. 8	None.	None.	0.00	7.40	–	–	.0000	.0032	.56	.0300	.0000
1968	Mar. 7	Mar. 8	Slight.	None.	0.05	7.25	–	–	.0004	.0052	.50	.0350	.0001
2180	Apr. 10	Apr. 11	Slight.	Very slight.	0.30	5.60	–	–	.0004	.0088	.42	.0200	.0000
2374	May 8	May 9	None.	Con., brown.	0.00	7.40	–	–	.0006	.0058	.57	.0300	.0000
2560	June 6	June 7	None.	None.	0.10	6.70	–	–	.0000	.0032	.54	.0200	.0001
2706	July 4	July 5	Very slight.	None.	0.00	6.45	–	–	.0000	.0054 .0046	.52	.0180	.0000
2894	Aug. 7	Aug. 8	Slight.	Very slight.	0.00	6.28	–	–	.0000	.0054 .0052	.51	.0230	.0001
3345	Oct. 10	Oct. 11	Very slight.	Very slight.	0.00	7.05	–	–	.0002	.0052 .0052	.54	.0350	.0002
3450	Oct. 25	Oct. 26	None.	None.	0.00	7.25 7.15	–	–	.0004	.0054 .0054	.55	.0300	.0000
3506	Nov. 7	Nov. 8	Very slight.	Slight.	0.00	7.15 7.05	–	–	.0000	.0048 .0044	.50	.0250	.0000
3657	Dec. 5	Dec. 6	None.	Slight.	0.10	5.55 5.50	–	–	.0000	.0100 .0092	.46	.0250	.0001
	1889.												
3901	Jan. 22	Jan. 23	Very slight.	Very slight.	0.05	5.50 5.50	–	–	.0000	.0050 .0050	.46	.0300	.0001
3978	Feb. 6	Feb. 7	Very slight.	Slight.	0.00	6.15	–	–	.0000	.0052 .0032	.50	.0400	.0000
4057	Feb. 20	Feb. 21	None.	None.	0.00	6.25	–	–	.0004	.0040	.53	.0210	.0003
4240	Mar. 7	Mar. 8	Very slight.	Very slight.	0.05	6.80 6.50	–	–	.0000	.0030 .0030	.53	.0350	.0000
4501	Apr. 11	Apr. 12	None.	Very slight.	0.00	6.30	–	–	.0000	.0030 .0028	.55	.0250	.0000
4635	May 8	May 9	None.	None.	0.00	6.90	–	–	.0000	.0030 .0026	.56	.0400	.0000
Av.	....	....	....	....	0.03	6.79			.0001	.0044	.53	.0287	.0001

Hardness in May, 1888, 3.5. Odor, none.——The samples were collected from a faucet at the high-service tank, except No. 2560, which was taken from a faucet in the high-service pumping station just before beginning to pump. The pumping station is about two miles from the tank. Samples were generally taken when the water in the tank was at the lowest point it is allowed to reach before refilling, and in some cases no water had been discharged into the tank for seven days. The tank was covered to exclude the light Aug. 11, 1887. It was also cleaned on that date and found to contain much sediment. It has been emptied for examination since that date, but no sediment was found.

Microscopical Examination.

	1888.									1889.					
	Apr.	May.	June.	July.	Aug.	Oct.	Oct.	Nov.	Dec.	Jan.	Feb.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ,	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, .	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	pr.	0.2
3. Fungi, . . .	0.0	pr.	pr.	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, .	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Groups and principal genera of organisms observed: 2. Palmellaceæ; Diatomaceæ. 3. Schizomycetes.

Chemical Examination of Water from Charles River opposite the Filter-Gallery of the Brookline Water Works at West Roxbury.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
43	June 6	June 8	Very slight.	None.	1.20	5.15	2.27	2.88	.0042	.0423	.44	–	–
253	July 6	July 6	Very slight.	None.	0.90	4.92	1.77	3.15	.0011	.0251	.38	–	–
494	Aug. 8	Aug. 8	Very slight.	None.	1.10	5.85	1.90	3.95	.0002	.0274	.32	.0070	–
711	Sept. 8	Sept. 9	Slight.	Slight.	0.80	5.67	1.49	4.18	.0010	.0322	.39	.0070	–
913	Oct. 10	Oct. 11	Very slight.	Very slight.	0.40	4.80	1.15	3.65	.0005	.0202	.53	.0130	–
1119	Nov. 8	Nov. 9	Slight.	Slight.	0.60	5.85	1.15	4.70	.0008	.0218	.59	.0080	–
1353	Dec. 8	Dec. 9	Distinct.	Slight.	0.70	6.20	1.95	4.25	.0009	.0278	.52	.0180	–
	1888.												
1557	Jan. 9	Jan. 10	Slight.	Very slight.	1.10	4.95	1.90	3.05	.0010	.0261	.32	.0250	.0000
1765	Feb. 7	Feb. 8	Slight.	Considerable, earthy.	0.60	5.35	1.70	3.65	.0069	.0257	.34	.0200	.0000
1966	Mar. 7	Mar. 8	Slight.	Very slight.	0.70	4.50	1.60	2.90	.0003	.0278	.30	.0100	.0000
2178	Apr. 10	Apr. 11	Distinct.	Very slight.	1.10	3.50	1.45	2.05	.0004	.0247	.24	.0040	.0001
2371	May 8	May 9	Distinct.	Con., dark brown.	0.80	4.10	1.60	2.50	.0022	.0264	.34	.0080	.0000
2557	June 6	June 7	Very slight.	Slight.	1.30	4.80	1.88	2.92	.0034	.0320	.30	.0050	.0003
2705	July 4	July 5	Very slight.	Very slight.	0.60	4.55	1.70	2.85	.0010	.0234 .0216	.35	.0080	.0001
2891	Aug. 7	Aug. 8	Slight.	Very slight.	0.45	4.60	1.40	3.20	.0000	.0228 .0208	.42	.0030	.0001
3343	Oct. 10	Oct. 11	Slight.	Very slight.	1.20	5.30	2.25	3.05	.0026	.0322 .0300	.37	.0080	.0002
3447	Oct. 25	Oct. 26	Very slight.	Very slight.	1.30	5.00	2.15	2.85	.0008	.0268 .0258	.42	.0100	.0002
3503	Nov. 7	Nov. 8	Very slight.	Slight.	1.30	5.25	2.40	2.85	.0010	.0298 .0256	.40	.0060	.0001
3655	Dec. 5	Dec. 6	Very slight.	Very slight.	0.50	3.80	1.40	2.40	.0006	.0216 .0186	.36	.0100	.0001

Chemical Examination of Water from Charles River opposite the Filter-Gallery of the Brookline Water Works at West Roxbury — Concluded.

Number.	Date of Collection.	Date of Exam-ination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albu-minoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
3898	Jan. 22	Jan. 23	Very slight.	Very slight.	0.50	3.40	1.25	2.15	.0000	.0156 .0136	.34	.0060	.0000
3976	Feb. 6	Feb. 7	Very slight.	Very slight.	0.50	3.55	0.80	2.75	.0002	.0152 .0130	.33	.0080	.0002
4054	Feb. 20	Feb. 21	Distinct.	Slight.	0.40	4.00	1.20	2.80	.0002	.0176 .0152	.31	.0060	.0003
4237	Mar. 7	Mar. 8	Distinct.	Slight.	0.30	3.80	1.50	2.30	.0002	.0164 .0150	.35	.0120	.0002
4498	Apr. 11	Apr. 12	Slight.	Very slight.	0.70	3.85	1.30	2.55	.0002	.0224 .0200	.34	.0040	.0004
4632	May 8	May 9	Slight.	Slight.	1.20	4.50	1.95	2.55	.0018	.0306 .0258	.32	.0100	.0002
Av.	....	....	....	....	0.81	5.07	1.66	3.41	.0013	.0254	.37	.0094	.0001

Hardness in May, 1888, 1.6. Odor, generally faintly vegetable, seldom mouldy.——The samples were collected from the river near the filter-gallery of the Brookline Water Works at West Roxbury.

Microscopical Examination.

	1888.							1889.					
	June.	July.	Aug.	Oct.	Oct.	Nov.	Dec.	Jan.	Feb.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ,	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, .	pr.	0.9	1.8	0.2	0.6	pr.	0.0	0.5	0.3	pr.	2.9	0.8	0.9
3. Fungi, . . .	1.5	0.5	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, .	pr.	0.2	0.4	0.5	0.6	0.0	0.0	pr.	pr.	0.0	0.6	pr.	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Synedra*. 3. Schizomycetes, *Crenothrix*. 4. Protozoa; Spongiaria; Annelida; Entomostraca.

Water Supply of Cambridge.

Description of Works. — Population in 1885, 59,658. The works are owned by the city. Water was introduced in 1856. The average daily consumption in 1888 was 4,138,000 gallons. The sources of supply are Fresh Pond in Cambridge and a storage reservoir on Stony Brook in Waltham and Weston.

Fresh Pond, the original source of supply, is a natural pond. Its maximum depth is about 46 feet. The character of the bottom is variable, consisting of clay, gravel and vegetable deposits. Many improvements have recently been made in the pond and its immediate surroundings to make it a more satisfactory reservoir for the storage of water. Several "nooks" in which the water was shallow have been cut off from the pond by means of dams, and others have been deepened, so that practically the entire area of the pond has now a depth of at least 9 feet at high water. In making these improvements the area of the pond has been reduced about 20 acres, and its present area is about 165 acres. The boundaries of the area contributing water to the pond are somewhat indefinite, since much of the water entering the pond filters through the ground from areas beyond the superficial watershed; moreover, the contributing area enlarges as the pond is drawn down. By the latest estimates this area is placed at 569 acres. It contains a large population.

Stony Brook storage reservoir was completed in 1887. It is about $1\frac{1}{4}$ miles in length and one-fourth of a mile in width. The shores are bold and rocky and the available depth of water in the reservoir when full is 20 feet. Its area is 75 acres; capacity, 354,000,000 gallons; average depth, about 15 feet. The bottom and sides were carefully cleaned by removing the mud or by covering it with gravel, and by removing the trees, stumps and other objectionable matter. About 80,000 cubic yards of mud were taken out. The bottom is now of clay in some places and of gravel and bowlders in others. There is practically no shallow flowage. The drainage area of 21 square miles includes much of the area of the towns of Weston and Lincoln, a considerable area in the city of Waltham, and a very small one in Lexington. At the head of Stony Brook is Sandy Pond, which is the source of the water-supplies of the towns of Concord and Lincoln; it has an area of about 152 acres. On a small branch which enters Stony Brook below Sandy Pond is Beaver Pond, which is said to have an area of about 20 acres. There are no other large ponds in the drainage area. The region contains two hills of considerable height, but is otherwise a gently rolling country, containing a scattered farming population and a few small villages. The total population is about 1,900, or 90 to the square mile. There is no sewerage system in any portion of this area, and only

a very small population, in the town of Lincoln, is provided with a public water supply.

High-water mark in the Stony Brook storage reservoir is about 65 feet above that in Fresh Pond. Water flows from the former into the latter through a single line of cast-iron pipe. This pipe is 36 inches in diameter from the storage reservoir to a point opposite the pumping station of the Waltham water works, and 30 inches in diameter the remainder of the distance to Fresh Pond. At the pond provision is made for aerating the water by discharging it into the air through numerous apertures in a cap on the end of the pipe. The pond is now used to a great extent as a storage reservoir for Stony Brook water. This water was first let into the pond in large quantities, Nov. 5, 1887, and the change produced in the character of the water in the pond by the admission of the reservoir water can be seen by reference to the chemical analyses of the water of the pond as given on pages 90 and 91. From Fresh Pond pumps force the water to an open distributing reservoir used to supply the low-service districts, and to a covered iron standpipe used to supply the high-service districts. The distributing reservoir is 340 feet long, 170 feet wide and 15 feet deep. It is divided by a partition wall into two parts, each of which has a separate supply pipe. Its total capacity is 5,375,000 gallons. The bottom is covered with a layer of concrete 4 inches in thickness, and the slopes are paved with granite blocks laid in cement. The standpipe is 5.4 feet in diameter, and is protected by a circular building which is used as an observation tower. Distributing mains are of cast iron. Service pipes are of galvanized iron.

In 1876 a conduit was built to connect Fresh Pond with Wellington Brook and a filter-gallery on the shore of Little Pond, and the city depended upon these auxiliary sources of supply to fill up Fresh Pond in the winter and spring when the water was of the best quality; but on account of the increasing danger of pollution these sources of supply were abandoned upon the completion of the Stony Brook works.

Chemical Examination of Water from Stony Brook Storage Reservoir in Waltham.

[Parts per 100,000.]

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.	Chlorine.	Nitrates.	Nitrites.
	1887.												
44	June 6	June 8	Very slight.	None.	1.30	6.72	3.25	3.47	.0060	.0552	.45	.0000	–
337	July 14	July 15	Distinct.	Slight.	0.70	6.25	1.72	4.53	.0006	.0297	.35	.0030	–
516	Aug. 9	Aug. 11	Very slight.	Slight, rusty.	1.00	5.92	1.80	4.12	.0024	.0266	.45	.0000	–
715	Sept. 8	Sept. 9	Decided.	Slight.	0.70	6.30	1.12	5.18	.0061	.0366	.42	.0030	–
954	Oct. 13	Oct. 14	Distinct.	Slight.	0.70	6.05	1.25	4.80	.0074	.0340	.43	.0070	–
1114	Nov. 7	Nov. 8	Slight.	Slight.	0.45	6.00	1.75	4.25	.0071	.0262	.48	.0080	–
	1888.												
1555	Jan. 6	Jan. 9	Slight.	Very slight.	0.80	5.30	1.85	3.45	.0004	.0226	.26	.0480	.0000
1775	Feb. 6	Feb. 8	Slight.	Very slight.	0.20	4.35	1.30	3.05	.0102	.0145	.19	.0290	.0000
1960	Mar. 6	Mar. 7	Distinct.	Slight.	0.50	4.65	1.70	2.95	.0050	.0358	.34	.0180	.0001
2173	Apr. 9	Apr. 10	Slight.	Very slight.	0.75	4.20	1.45	2.75	.0012	.0276	.30	.0100	.0002
2367	May 7	May 8	Slight.	Very slight.	1.00	5.15	1.95	3.20	.0008	.0248	.41	.0120	.0002
2578	June 7	June 8	Very slight.	Considerable.	1.00	5.50	2.15	3.35	.0018	.0368 .0272	33	.0080	.0003
2745	July 9	July 10	Very slight.	Slight.	0.90	5.40	2.20	3.20	.0040	.0346 .0224	.37	.0100	.0002
2879	Aug. 2	Aug. 3	Distinct.	Slight.	0.70	5.05	1.40	3.65	.0010	.0288 .0234	.41	.0020	.0002
3096	Sept. 6	Sept. 7	Decided.	Slight.	0.50	5.40	2.10	3.30	.0046	.0322 .0248	.34	.0030	.0003
3312	Oct. 4	Oct. 5	Slight.	Slight, green.	1.30	6.05	2.35	3.70	.0060	.0394 .0348	.30	.0080	.0002
3507	Nov. 7	Nov. 8	Very slight.	Slight.	1.10	6.30	2.70	3.60	.0012	.0274 .0262	.44	.0150	.0001
3666	Dec. 6	Dec. 7	None.	Very slight.	0.55	4.40	2.05	2.35	.0004	.0176 .0154	.39	.0400	.0001
	1889.												
3832	Jan. 8	Jan. 9	Distinct.	Slight, earthy.	0.60	4.15	1.30	2.85	.0024	.0258 .0212	.37	.0280	.0003
3986	Feb. 7	Feb. 8	Very slight.	Very slight.	0.30	4.40	1.20	3.20	.0008	.0142 .0114	.39	.0300	.0002
4245	Mar. 7	Mar. 8	Slight.	Slight.	0.50	4.90	1.60	3.30	.0026	.0162 .0132	.40	.0300	.0002
4470	Apr. 4	Apr. 6	Very slight.	Very slight.	0.35	4.40	1.15	3.25	.0022	.0232 .0200	.38	.0200	.0004
4617	May 6	May 7	Slight.	Slight.	0.80	5.10	2.10	3.00	.0016	.0272 .0248	.38	.0150	.0003
Av.	....	....	....	....	0.73	5.54	1.74	3.80	.0033	.0286	.37	.0151	.0002

Hardness in May, 1888, 2.4. Odor, generally faintly vegetable.—— The samples were collected from the reservoir with the exception of No. 44, which was collected from the brook just above the dam before the reservoir was finished. Nos. 337, 516, 715 and 1114 were collected near the middle of the reservoir when it was about half full. For heights of water in this reservoir at the times when samples of water were collected for analysis, see page 92.

Microscopical Examination.

	1888.									1889.				
	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ, .	0.0	–	0.0	0.1	0.1	0.1	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, . .	pr.	–	0.9	11.3	6.3	3.7	1.9	0.0	0.4	0.6	0.3	0.0	0.2	0.8
3. Fungi, ...	0.0	–	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, . .	0.0	–	4.0	0.2	3.2	0.2	0.1	0.0	0.1	pr.	0.0	0.2	pr.	pr.

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ, *Chlorococcus;* Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Asterionella*, *Melosira*, *Stephanodiscus;* Zygnemaceæ. 3. Schizomycetes. 4. Protozoa, *Dinobryon*, *Peridinium;* Rotifera; Entomostraca.

Chemical Examination of Water from Fresh Pond in Cambridge.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.	1887.											
65	June 9	June 10	Slight, milky.	Very slight.	0.00	17.12	1.45	15.67	.0002	.0134	2.11	.0390	–
295	July 11	July 11	Slight.	Slight.	0.00	17.60	3.10	14.50	.0012	.0114	2.07	.0330	–
518	Aug. 10	Aug. 11	Slight.	Slight.	0.00	16.80	2.05	14.75	.0013	.0139	2.15	.0260	–
706	Sept. 7	Sept. 8	Decided.	Slight.	0.00	17.65	0.90	16.75	.0049	.0141	2.25	.0260	–
902	Oct. 7	Oct. 8	Slight.	Slight.	0.10	17.85	2.15	15.70	.0000	.0206	2.03	.0260	–
1112	Nov. 7	Nov. 8	Slight.	Con., green.	0.10	18.70	2.05	16.65	.0374	.0312	2.21	.0240	–
1362	Dec. 9	Dec. 9	Distinct, milky.	Considerable, green.	0.10	15.50	1.90	13.60	.0284	.0215	1.94	.0120	–
	1888.	1888.											
1544	Jan. 6	Jan. 6	Decided.	Slight, earthy.	0.20	14.35	2.15	12.20	.0242	.0182	1.62	.0180	.0010
1752	Feb. 6	Feb. 6	Slight.	Very slight.	0.15	12.40	2.35	10.05	.0192	.0191	1.37	.0300	.0005
1976	Mar. 8	Mar. 8	Slight.	Very slight.	0.30	11.35	1.95	9.40	.0186	.0196	1.13	.0300	.0005
2164	Apr. 9	Apr. 9	Distinct.	Consid'ble.	0.30	11.20	1.05	10.15	.0084	.0259	1.11	.0200	.0004
2363	May 7	May 7	Slight.	Consid'ble.	0.40	10.60	2.00	8.60	.0038	.0240	1.08	.0250	.0006
2550	June 5	June 6	Slight.	Considerable, white.	0.20	10.13	1.65	8.48	0074	.0212 .0162	1.00	.0250	.0005
2741	July 9	July 9	Decided.	Slight, white.	0.15	9.60	1.55	8.05	.0032	.0170 .0170	0.97	.0220	.0007
2886	Aug. 6	Aug. 6	Slight.	Very slight.	0.00	14.80	2.00	12.80	.0018	.0214 .0172	1.02	.0300	.0005
3075	Sept. 5	Sept. 6	Distinct.	Slight, white.	0.10	9.80	1.45	8.35	.0014	.0226 .0182	0.96	.0400	.0007
3311	Oct. 4	Oct. 4	Very slight.	Slight, green.	0.05	9.50	1.35	8.15	.0070	.0176 .0146	0.93	.0180	.0010
3497	Nov. 7	Nov. 7	Slight.	Very slight.	0.10	9.90	1.95	7.95	.0324	.0202 .0168	0.96	.0250	.0010
3654	Dec. 6	Dec. 6	Distinct.	Slight.	0.05	10.00	2.05	7.95	.0310	.0202 .0184	0.98	.0300	.0008

Chemical Examination of Water from Fresh Pond in Cambridge — Concluded.

Number.	Date of Collection.	Date of Exam-ination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albu-minoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
3831	Jan. 8	Jan. 8	Slight.	Con., light green.	0.10	9.55	1.45	8.10	.0276	.0192 .0148	0.97	.0220	.0006
3980	Feb. 7	Feb. 7	Very slight.	Very slight.	0.05	9.85	1.45	8.40	.0218	.0198 .0162	0.95	.0500	.0007
4230	Mar. 7	Mar. 7	Very slight.	Very slight.	0.10	10.45	2.55	7.90	.0192	.0178 .0144	1.01	.0500	.0007
4468	Apr. 5	Apr. 5	Distinct.	Slight, white.	0.05	9.65	1.30	8.35	.0144	.0206 .0154	0.96	.0500	.0009
4616	May 6	May 7	Slight.	Slight.	0.15	9.80	2.40	7.40	.0064	.0200 .0168	0.95	.0040	.0006
Av.	....	....	....	....	0.11	15.09	1.93	13.16	.0134	.0196	1.37	.0281	.0007

Hardness in June, 1887, 10.2; in July, 1887, 8.7; in May, 1888, 6.0; in May, 1889, 5.0. Odor, generally faintly vegetable, sometimes none. —— The samples were collected from the pump well at the pumping station. Water was let into the pond from Stony Brook Saturday, Nov. 5, 1887, at 10.30 A.M. For heights of water in this pond at the times when samples of water were collected for analysis, see page 92.

Microscopical Examination.

	1888. June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	1889. Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ, ...	5.0	0.1	0.2	0.1	0.1	pr.	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	9.2	25.3	3.8	1.8	0.7	12.6	5.1	17.8	3.1	0.1	2.1	6.4
3. Fungi, ...	0.0	0.0	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, ...	0.4	0.2	3.0	2.4	0.1	0.1	0.2	2.0	0.3	4.8	10.0	0.6

Groups and principal genera of organisms observed: 1. Cyanophyceæ, *Aphanocapsa*. 2. Palmellaceæ, *Chlorococcus;* Zoosporeæ, *Conferva;* Desmidiaceæ; Diatomaceæ, *Asterionella*, *Fragillaria*, *Melosira*, *Stephanodiscus*, *Synedra;* Zygnemaceæ. 3. Schizomycetes. 4. Protozoa, *Dinobryon*, *Trachelomonas;* Rotifera; Entomostraca.

Chemical Examination of Water from Stony Brook Conduit.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Exam-ination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albu-minoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
739	Sept. 12	Sept. 13	Distinct.	Slight.	0.6	6.27	1.57	4.70	.0083	.0344	.44	–	–

Odor, faintly vegetable. —— The sample was collected from the conduit where it enters Fresh Pond.

Table showing Heights of Water in Stony Brook Reservoir and Fresh Pond at the times when Samples of Water were Collected for Analysis.

Heights are in feet above Cambridge City Base.

Fresh Pond. High Water, 16.85.		Stony Brook. Rollway, 81.00.	
Date.	Height of Water.	Date.	Height of Water.
1887.		**1887.**	
June 9,	6.97	June 6,	58.80
July 11,	5.42	July 14,	70.00
August 10,	4.34	August 9,	74.70
September 7,	3.61	September 8,	75.00
October 7,	4.60	October 13,	72.50
November 5,	3.32	–	–
November 7,	3.59	November 7,	74.30
December 9,	7.53	–	–
1888.		**1888.**	
January 6,	–	January 6,	81.01
February 6,	–	February 7,	80.81
March 8,	14.56	March 6,	81.00
April 9,	15.67	April 9,	81.45
May 7,	16.20	May 7,	80.95
June 5,	15.90	June 7,	80.88
July 9,	14.94	July 9,	80.45
August 6,	13.18	August 2,	79.19
September 5,	13.07	September 6,	79.85
October 4,	15.16	October 4,	81.21
November 7,	15.73	November 7,	81.10
December 6,	15.76	December 6,	81.57
1889.		**1889.**	
January 8,	16.62	January 8,	82.45
February 7,	15.77	February 7,	81.11
March 7,	–	March 7,	81.59
April 5,	16.01	April 4,	81.42
May 6,	15.94	May 6,	81.00

Water Supply of Canton.

Description of Works. — Population in 1885, 4,380. The works are owned by the town. Water was introduced in May, 1889. The source of supply is a large well located near Springdale station on the Stoughton branch of the Old Colony Railroad and not far from the boundary line between Canton and Stoughton. The well is about 40 feet in diameter and is situated near Beaver Brook. In addition to the large well about ten tubular wells in its vicinity are connected with the pumps. Water was pumped from these wells during the construction of the large well to lower the ground water. Pumps force the water from the wells to an open iron tank 35 feet in diameter and 65 feet in height. Distributing mains are of cast iron. Service pipes are of wrought iron, lined with cement, and enameled iron. The act of the Legislature under which the works have been constructed also authorized the town to take water from York Pond and Beaver Brook in Stoughton and Canton.

Chemical Examination of Water from the Well and Tubular Wells of the Canton Water Works.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1888.	1888.											
3526	Nov. 12	Nov. 12	Very slight.	None.	0.0	5.70	–	–	.0000	.0004	.43	.0750	.0000
	1889.	1889.											
4759	June 2	June 3	None.	None.	0.0	6.45	–	–	.0022	.0034	.41	.0800	.0014

Hardness in June, 1889, 3.6. Odor, none.—— Sample No. 3526 was collected from the discharge pipe of a pump drawing water from tubular wells in the vicinity of the proposed collecting well. No. 4759 was collected from a faucet at the pumping station soon after the latter was completed and before the well had been thoroughly cleaned after its completion.

Microscopical Examination.

November, 1888. No organisms present.

Chemical Examination of Water from York Pond in Canton.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
3525	Nov. 12	Nov. 12	Slight.	Slight.	0.1	2.50	0.90	1.60	.0030	.0154 .0124	.27	.0050	.0000

Odor, very faintly grassy. —— The sample was collected from York Pond at the artificial outlet at the south end.

Microscopical Examination.

November, 1888. — 1. Blue-green algæ, 0.0; 2. Other algæ, 2.3; 3. Fungi, 0.0; 4. Animal forms, 0.8. Groups and principal genera of organisms observed: 2. Palmellaceæ; Diatomaceæ. 4. Protozoa.

Water Supply of Chelsea.

Description of Works. — Population in 1885, 25,709. The works are owned by the city. Water was introduced in 1867. The source of supply is Upper Mystic Lake, from which water is furnished to Chelsea by the city of Boston from the Mystic Works. A high-service system was constructed in 1886, and water for the high-service districts is pumped from the main supply pipe to a reservoir on Powder Horn Hill. This reservoir is 148 feet long by 68 feet wide on the bottom and 178 feet long by 98 feet wide at the top. It is 15 feet in depth and its capacity is one million gallons. The bottom and slopes are covered with concrete. The distributing mains were originally of wrought iron lined with cement; cast iron has been used in repairs and extensions for several years, and in 1888 about 28 per cent. of the distributing mains were of cast iron. Service pipes are of lead. For a description of the source of supply and analyses of the water, see *Boston, Mystic Works.*

Water Supply of Cheshire. — Cheshire Water Company.

Description of Works. — Population in 1885, 1,448. The works are owned by the Cheshire Water Company. Water was introduced in 1876. About 200 people were supplied in 1887. The source of supply is a very small storage reservoir fed by springs. The reservoir is 200 feet long by 66 feet wide and 10 feet deep, built of stone laid in cement; the bottom is of gravel. Water is distributed by gravity. Distributing mains are of cast iron. Service pipes are of wrought iron galvanized.

Chemical Examination of Water from the Reservoir of the Cheshire Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
54	June 7	June 9	Slight.	None.	0.0	4.65	–	–	.0003	.0050	.07	.0130	–
278	July 7	July 8	Very slight.	None.	0.0	4.20	–	–	.0000	.0042	.08	.0030	–
477	Aug. 4	Aug. 5	None.	None.	0.0	4.40	–	–	.0001	.0027	.07	.0130	–
1021	Oct. 24	Oct. 25	Very slight.	Slight, earthy.	0.0	4.90	–	–	.0000	.0024	.07	.0090	–
1140	Nov. 9	Nov. 10	None.	None.	0.0	4.75	–	–	.0004	.0020	.08	.0180	–
	1888.												
1959	Mar. 5	Mar. 7	None.	Very slight.	0.0	3.95	–	–	.0000	.0024	.05	.0250	.0000
2419	May 14	May 15	None.	Very slight.	0.0	2.85	–	–	.0000	.0018	.05	.0100	.0000
Av.	....	....	....	....	0.0	4.24	–	–	.0001	.0029	.07	.0130	–

Hardness in May, 1888, 2.0. Odor, none. —— The samples were collected from a faucet in the village. Nos. 54 and 278 were collected soon after heavy rains.

Microscopical Examination.

May, 1888. 1. Blue-green algæ, 0.0; 2. Other algæ, pr.

Groups and principal genera of organisms observed: 2. Diatomaceæ.

Chemical Examination of Water from Cheshire Reservoir in Cheshire.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
3281	Sept. 27	Sept. 28	Distinct.	Slight, brown.	0.2	8.35	1.90	6.45	.0008	.0262 .0190	.09	.0030	.0001

Odor, faintly earthy. —— The sample was collected from the Cheshire reservoir near the outlet. This reservoir is at the head of the south branch of the Hoosac River.

Microscopical Examination.

September, 1888. 1. Blue-green algæ, pr.; 2. Other algæ, 0.5; 3. Fungi, 0.0; 4. Animal forms, 0.6.

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Zoosporeæ; Diatomaceæ; Desmidiaceæ. 4. Protozoa.

Water Supply of Chicopee Central Fire District, Chicopee. Chicopee Water Company.

Description of Works. — Population of the town of Chicopee in 1885, 11,516. Exclusive of Chicopee Falls Fire District the population is about 7,500. The works are owned by the Chicopee Water Company. Water was first introduced in 1845. The pres-

ent corporation bought the old works in 1877 and rebuilt them. Water is said to be supplied to about 6,500 people. The sources of supply are a storage reservoir on Dingle Brook in Springfield, near the boundary between Springfield and Chicopee, and six wells located about one mile south of the village of Chicopee. The area of the storage reservoir is about 3.5 acres; capacity, 5,250,000 gallons; average depth, about 5 feet; maximum depth, 20 feet. There is considerable shallow flowage. The drainage area is generally woodland and the soil is sandy. There are very few inhabitants on the area. The water runs by gravity to a distributing reservoir and to the village. The area of the distributing reservoir is about one acre. Water from Dingle Brook storage reservoir is also pumped to an iron tank 40 feet high and 30 feet in diameter, which furnishes water to the fire-service system of pipes.

The wells supply about 100 families. There are six wells from 4 to 12 feet square and 10 to 12 feet deep, dug in the bottom of an excavation originally made for the purpose of obtaining sand, and, since water frequently fills this excavation, it is known as Sand Bank Pond. This pond has a very small direct drainage area, but, as the land about it is nearly level and the soil is porous, most of the water entering the pond or wells filters through the ground. Water from this source is supplied by gravity through an independent system of pipes. Distributing mains are of cement-lined wrought iron and of cast iron. Service pipes are nearly all of lead.

Chemical Examination of Water from Dingle Brook Storage Reservoir.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
138	June 17	June 20	Decided.	Much.	0.40	4.22	1.05	3.17	.0002	.0281	.22	.0130	–
364	July 19	July 20	Slight.	Much.	0.80	4.65	1.05	3.60	.0016	.0198	.18	.0070	–
566	Aug. 16	Aug. 18	Slight.	Consid'ble.	0.40	4.45	1.17	3.28	.0000	.0140	.16	.0070	–
790	Sept. 14	Sept. 16	Decided.	Slight.	0.15	4.20	0.50	3.70	.0012	.0112	.21	.0070	–
965	Oct. 17	Oct. 18	Slight.	Sli't, white.	0.40	3.90	0.30	3.60	.0003	.0131	.18	.0030	–
1194	Nov. 15	Nov. 16	Distinct.	Slight.	0.20	3.90	1.60	2.30	.0003	.0133	.21	.0040	–
1441	Dec. 19	Dec. 20	Distinct.	Very slight.	0.20	4.00	0.75	3.25	.0009	.0106	.19	.0120	–
	1888.												
1622	Jan. 17	Jan. 19	Slight.	Slight.	0.10	3.65	0.60	3.05	.0029	.0040	.18	.0250	–
1828	Feb. 14	Feb. 15	Very slight.	Slight.	0.10	3.75	0.65	3.10	.0060	.0066	.16	.0150	.0002

Chemical Examination of Water from Dingle Brook Storage Reservoir — Concluded.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
2047	Mar. 19	Mar. 20	Very slight.	Slight.	0.20	3.35	0.55	2.80	.0028	.0070	.16	.0250	.0004
2238	Apr. 17	Apr. 18	Distinct.	Slight.	0.10	2.70	0.65	2.05	.0000	.0078	.15	.0230	.0002
2477	May 21	May 22	Distinct.	Consid'ble.	0.10	3.80	0.90	2.90	.0010	.0136	.16	.0120	.0001
2709	July 3	July 5	Distinct.	Consid'ble.	0.25	3.60	0.65	2.75	.0010	.0170 .0100	.15	.0080	.0001
2834	July 24	July 25	Slight.	Slight, green.	0.05	3.40	0.50	2.90	.0000	.0170 .0110	.18	.0020	.0001
3000	Aug. 20	Aug. 21	Slight.	Slight.	0.10	4.30	0.85	3.45	.0002	.0138 .0114	.16	.0090	.0003
3247	Sept. 21	Sept. 22	Slight.	Slight.	0.15	4.25	1.05	3.20	.0004	.0186 .0128	.17	.0100	.0002
3414	Oct. 19	Oct. 20	Slight.	Considerable.	0.25	3.70	0.65	3.05	.0002	.0144 .0070	.17	.0070	.0004
3603	Nov. 23	Nov. 24	Distinct.	Considerable.	0.10	3.60	0.75	2.85	.0004	.0190 .0074	.18	.0200	.0003
3766	Dec. 19	Dec. 20	Distinct.	Considerable.	0.05	3.20	0.70	2.50	.0004	.0078 .0060	.17	.0280	.0005
	1889.												
3912	Jan. 23	Jan. 24	Slight.	Considerable.	0.10	3.10	0.45	2.65	.0002	.0152 .0098	.15	.0300	.0003
4131	Feb. 26	Feb. 27	Very slight.	Slight.	0.10	3.70	0.70	3.00	.0010	.0074 .0044	.15	.0300	.0001
4399	Mar. 26	Mar. 27	Very slight.	Very slight.	0.05	3.20	0.55	2.65	.0000	.0088 .0064	.14	.0250	.0002
4561	Apr. 23	Apr. 24	Very slight.	Considerable.	0.10	3.50	0.55	2.95	.0016	.0170 .0112	.12	.0070	.0002
4709	May 21	May 22	Distinct.	Heavy, yellow green.	0.30	3.65	0.80	2.85	.0012	.0180 .0116	.12	.0020	.0002
Av.	....	....	....	....	0.20	3.88	0.81	3.07	.0010	.0135	.17	.0138	.0002

Hardness in May, 1888, 1.6. Odor, often none, occasionally vegetable, seldom mouldy and disagreeable. —— The samples were collected from a faucet in the village of Chicopee.

Microscopical Examination.

	1888. Mar.	Apr.	May.	July.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	1889. Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ,	0.0	–	–	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, .	0.0	–	–	11.9	132.6	4.4	0.9	0.8	0.3	1.2	0.2	0.0	0.1	0.7	7.2
3. Fungi, . .	0.0	–	–	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, .	0.0	–	–	2.7	4.4	0.4	pr.	0.7	0.1	1.6	pr.	0.1	4.1	0.7	pr.

Groups and principal genera of organisms observed: 2. Palmellaceæ; Zoosporeæ, *Scenedesmus;* Desmidiaceæ, *Staurastrum;* Diatomaceæ, *Asterionella, Melosira, Stephanodiscus, Synedra;* Zygnemaceæ. 4. Protozoa, *Dinobryon, Peridinium;* Annelida; Rotifera; Bryozoa; Entomostraca.

Chemical Examination of Water from Sand Bank Pond, Chicopee.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Exam-ination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albu-minoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
365	July 19	July 20	Slight, milky.	Slight.	0.00	3.57	0.97	2.60	.0000	.0139	.20	.0070	–
567	Aug. 16	Aug. 18	Very slight.	Slight.	0.00	3.72	0.37	3.35	.0000	.0073	.14	.0100	–
789	Sept. 14	Sept. 16	None.	Slight.	0.00	3.45	0.20	3.25	.0000	.0046	.19	.0100	–
966	Oct. 17	Oct. 18	Slight.	Slight.	0.00	3.65	0.45	3.20	.0000	.0060	.21	.0130	–
1195	Nov. 15	Nov. 16	Slight.	Considerable.	0.05	4.50	1.00	3.50	.0015	.0096	.35	.0500	–
1440	Dec. 19	Dec. 20	None.	Slight.	0.00	4.45	1.05	3.40	.0006	.0047	.26	.0760	–
	1888.												
1621	Jan. 17	Jan. 19	Very slight.	Slight.	0.00	4.25	0.90	3.35	.0000	.0033	.24	.0800	–
1829	Feb. 14	Feb. 15	Very slight.	Slight.	0.00	4.20	0.75	3.45	.0038	.0029	.35	.0900	.0002
2048	Mar. 19	Mar. 20	None.	Slight.	0.00	3.65	0.60	3.05	.0005	.0028	.20	.0700	.0001
2237	Apr. 17	Apr. 18	Very slight.	Very slight.	0.00	2.80	0.50	2.30	.0000	.0034	.12	.0300	.0000
2476	May 21	May 22	Very slight.	Slight, earthy.	0.00	3.00	0.35	2.65	.0000	.0034	.12	.0120	.0001
Av.	....	....	....	....	–	3.75	0.65	3.10	.0006	.0056	.22	.0407	.0001

Hardness in May, 1888, 1.7. Odor, generally none; seldom mouldy or disagreeable. —— The samples were collected from a faucet in the village of Chicopee.

Microscopical Examination.

	1888. March.	1888. April.	1888. May.
1. Blue-green Algæ, ...	0.0	0.0	0.0
2. Other Algæ, ...	pr.	pr.	pr.
3. Fungi, ...	0.0	0.0	pr.
4. Animal Forms, ...	pr.	0.0	0.0

Groups and principal genera of organisms observed: 2. Diatomaceæ. 3. Schizomycetes. 4. Protozoa.

Water Supply of Chicopee Falls Fire District, Chicopee.

Description of Works. — Population of the town of Chicopee in 1885, 11,516. The population of the Chicopee Falls Fire District in 1887 was estimated to be about 4,000. There are two distinct systems of supply. The principal system is owned by the Fire District. Water was introduced in 1883. The source of supply is the Chicopee River. Water is pumped from the canal of the Chicopee Manufacturing Company to a small covered reservoir. Distributing mains are of cast iron and service pipes of wrought iron. The works were originally built by the Chicopee Manufacturing Company, and the pump and reservoir are still owned by that corporation.

The second system of supply is owned by the Chicopee Manufacturing Company, and was introduced many years ago. In 1876 the wooden pipes which had been used for many years were replaced by iron pipes. The source of supply is a small reservoir 30 feet long, 20 feet wide and about 2 feet deep, which is fed by several springs. Water is distributed by gravity. Distributing mains are of iron. Service pipes are of lead.

Chemical Examination of Water from Chicopee River at Chicopee Falls.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.		Nitrates.	Nitrites.
	1887.												
137	June 17	June 18	Slight.	Consid'ble, rusty.	0.45	4.82	1.45	3.37	.0012	.0162	.17	.0130	–
366	July 19	July 20	Slight.	Consid'ble, rusty.	0.60	4.64	1.32	3.32	.0027	.0185	.19	.0070	–
563	Aug. 16	Aug. 18	Slight.	Slight.	1.00	5.05	1.52	3.53	.0026	.0238	.14	.0100	–
787	Sept. 15	Sept. 16	Decided.	Consid'ble.	0.45	4.35	0.95	3.40	.0026	.0188	.15	.0030	–
975	Oct. 17	Oct. 19	Slight.	Slight.	0.60	4.95	1.15	3.80	.0011	.0196	.24	.0080	–
1196	Nov. 15	Nov. 16	Distinct.	Slight.	0.40	4.20	1.10	3.10	.0006	.0155	.23	.0100	–
1442	Dec. 19	Dec. 20	Distinct.	Slight.	0.40	4.05	1.15	2.90	.0012	.0141	.21	.0120	–
	1888.												
1609	Jan. 16	Jan. 17	Distinct.	Slight, earthy.	0.30	3.95	1.10	2.85	.0000	.0109	.13	.0200	.0000
1843	Feb. 15	Feb. 17	Very slight.	Very slight.	0.40	3.90	0.85	3.05	.0040	.0159	.15	.0200	.0000
2019	Mar. 14	Mar. 16	Distinct.	Slight.	0.20	3.75	0.90	2.85	.0010	.0118	.17	.0100	.0002

Chemical Examination of Water from Chicopee River at Chicopee Falls — Con.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.	1888.											
2214	Apr. 13	Apr. 14	Very slight.	Slight, earthy.	0.30	3.00	0.95	2.05	.0004	.0142	.13	.0080	.0003
2407	May 11	May 12	Slight.	Slight.	0.25	3.40	1.20	2.20	.0012	.0126	.14	.0080	.0002
2643	June 20	June 21	Distinct.	Slight, green.	0.60	3.55	1.20	2.35	.0024	.0160	.12	.0060	.0002
2773	July 12	July 13	Slight.	Very slight.	0.30	4.55	1.55	3.00	.0038	.0178 .0140	.15	.0080	.0002
2950	Aug. 16	Aug. 17	Slight.	Slight, white.	0.25	4.65	0.95	3.70	.0018	.0162 .0126	.22	.0070	.0001
3224	Sept. 19	Sept. 20	Slight.	Considerable.	0.50	4.35	1.50	2.85	.0020	.0236 .0206	.19	.0120	.0001
3386	Oct. 17	Oct. 18	Slight.	Very slight.	1.00	4.00	1.35	2.65	.0002	.0150 .0144	.17	.0080	.0001
3586	Nov. 21	Nov. 22	Slight.	Slight.	0.50	3.45	1.10	2.35	.0000	.0140 .0128	.16	.0100	.0004
3765	Dec. 19	Dec. 20	Decided.	Heavy, earthy and flocculent.	0.40	2.60	1.05	1.55	.0002	.0202 .0116	.07	.0100	.0003
	1889.	1889.											
3911	Jan. 22	Jan. 24	Slight, milky.	Very slight.	0.20	2.95	0.65	2.30	.0000	.0132 .0102	.14	.0120	.0002
4155	Feb. 27	Feb. 28	Slight.	None.	0.20	3.70	0.85	2.85	.0000	.0126 .0070	.19	.0100	.0000
4415	Mar. 27	Mar. 28	Very slight.	Very slight.	0.30	3.25	0.85	2.40	.0000	.0124 .0100	.12	.0080	.0001
4568	Apr. 24	Apr. 25	Very slight.	Considerable, light.	0.25	3.30	0.90	2.40	.0012	.0164 .0142	.14	.0100	.0004
4718	May 22	May 23	Slight.	Considerable.	0.50	3.95	1.05	2.90	.0048	.0224 .0176	.14	.0060	.0003
Av.	....	....	....	....	0.43	4.17	1.14	3.03	.0015	.0163	.16	.0098	.0002

Odor, generally faintly vegetable, seldom mouldy. —— The samples were collected from a faucet in the pumping station, with the exception of No. 137 which was collected from the canal just over the inlet to the water works.

Microscopical Examination.

	1888. June.	1888. July.	1888. Aug.	1888. Sept.	1888. Oct.	1888. Nov.	1888. Dec.	1889. Jan.	1889. Feb.	1889. Mar.	1889. Apr.	1889. May.
1. Blue-green Algæ, ...	pr.	0.0	pr.	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.7
2. Other Algæ, ...	1.6	0.9	1.5	0.5	0.1	0.3	3.9	0.1	0.1	0.1	4.3	8.8
3. Fungi, ...	0.1	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, ...	0.1	pr.	0.0	0.0	0.0	pr.	pr.	0.0	0.0	pr.	0.3	0.1

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Synedra*, *Tabellaria*. 3. Schizomycetes. 4. Protozoa.

Chemical Examination of Water from the Springs of the Chicopee Manufacturing Company.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Exam-ination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albu-minoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
367	July 19	July 20	Very slight.	Very slight.	0.40	3.72	1.05	2.67	.0005	.0097	.19	.0070	–
564	Aug. 16	Aug. 18	Slight.	Slight.	0.20	4.62	0.82	3.80	.0004	.0091	.17	.0330	–
788	Sept. 15	Sept. 16	Decided.	Much.	0.05	5.20	1.05	4.15	.0000	.0144	.32	.0520	–
976	Oct. 17	Oct. 19	Very slight.	Slight.	0.10	4.30	0.70	3.60	.0000	.0052	.21	.0390	–
1197	Nov. 15	Nov. 16	Distinct.	Much.	0.50	4.85	1.10	3.75	.0002	.0158	.34	.0500	–
1443	Dec. 19	Dec. 20	Slight.	Slight.	0.20	4.05	0.70	3.35	.0000	.0066	.26	.0500	–
	1888.												
1610	Jan. 16	Jan. 17	Slight.	Slight.	0.10	4.20	0.75	3.45	.0008	.0024	.17	.0750	.0001
1844	Feb. 15	Feb. 17	None.	Very slight.	0.10	4.20	0.80	3.40	.0012	.0066	.23	.0650	.0001
2018	Mar. 14	Mar. 16	Very slight.	Very slight.	0.00	3.50	0.65	2.85	.0004	.0082	.20	.0600	.0001
2215	Apr. 13	Apr. 14	Very slight.	Much.	0.20	3.80	1.10	2.70	.0004	.0138	.17	.0600	.0003
2408	May 11	May 12	Slight.	Considerable.	0.10	3.45	1.00	2.45	.0000	.0078	.17	.0230	.0004
Av.	....	....	....	....	0.18	4.17	0.88	3.29	.0004	.0091	.22	.0467	.0002

Hardness in May, 1888, 1.5. Odor, very faint or none. —— The samples were collected from a faucet in the village of Chicopee Falls.

Microscopical Examination.

	1888. March.	1888. April.	1888. May.
1. Blue-green Algæ, ...	0.0	0.0	0.0
2. Other Algæ, ...	pr.	pr.	pr.
3. Fungi, ...	0.0	0.0	0.0
4. Animal Forms, ...	0.0	0.0	0.0

Groups and principal genera of organisms observed: 2. Desmidiaceæ; Diatomaceæ; Zoosporeæ.

Water Supply of Clinton.

Description of Works. — Population in 1885, 8,945. The works are owned by the town. Water was introduced in 1882. About 1,368 families were supplied in 1888. Water is supplied to the town by gravity from the watershed of Wekepeke Brook in Sterling. This

brook is formed by the confluence of two streams, the southerly one being known as Lynde's Brook and the northerly one as Heywood's Brook. The pipe leading to the town starts from a small reservoir, known as "the basin," located a short distance southerly from Lynde's Brook and not far above the confluence above mentioned. The basin has an area of 2.7 acres and a capacity of 3,000,000 gallons. Its slopes are paved and the bottom is sandy. A large amount of muck and other material was removed in constructing it. Provision has been made for connecting both Lynde's and Heywood's brooks with the basin, but Lynde's Brook is the one drawn from. Storage capacity in addition to that of the basin is furnished in part by two mill ponds on Lynde's Brook, now owned by the town, and by a new storage reservoir, built in 1888, upon the brook above the mill ponds. This reservoir has a capacity of 40,000,000 gallons and flows an area of 13½ acres. The basin has only a small superficial watershed; but, including Lynde's Brook above the point where its waters may be diverted, the total area contributing water to the basin, as estimated from the new topographical map of Massachusetts, is 1.16 square miles. The watersheds now used are generally hilly and wooded. The distributing reservoir in Clinton is 168 feet square at the top and contains 15 feet of water when full. The bottom is of concrete and the slopes are paved. Distributing mains are of cast iron and service pipes of wrought iron lined with cement. The town of Clinton sells water to the Lancaster Water Company to supply the town of Lancaster.

Chemical Examination of Water from "The Basin" of the Clinton Water Works, Sterling.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1887.												
187	June 23	June 24	None.	None.	0.10	4.67	0.97	3.70	.0008	.0102	.16	.0060	-
417	July 26	July 28	Very slight.	None.	0.70	4.95	1.07	3.88	.0008	.0121	.17	.0130	-
612	Aug. 24	Aug. 25	Very slight.	None.	0.60	4.92	1.32	3.60	.0010	.0111	.13	.0100	-
838	Sept. 21	Sept. 22	Distinct, milky.	Very slight.	0.20	5.17	0.87	4.30	.0002	.0079	.16	.0090	-

Chemical Examination of Water from "The Basin" of the Clinton Water Works, Sterling — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
1006	Oct. 20	Oct. 22	Very slight.	Very slight.	0.20	4.85	0.40	4.45	.0000	.0064	.18	.0100	–
1240	Nov. 21	Nov. 22	Very slight.	None.	0.20	4.25	0.70	3.55	.0007	.0092	.19	.0080	–
1471	Dec. 21	Dec. 22	Very slight.	None.	0.10	4.70	0.70	4.00	.0005	.0052	.17	.0100	.0000
	1888.												
1606	Jan. 16	Jan. 17	Very slight.	None.	0.20	4.70	0.65	4.05	.0000	.0042	.15	.0200	.0000
1816	Feb. 13	Feb. 14	None.	None.	0.05	4.05	0.70	3.35	.0008	.0063	.18	.0200	.0001
2061	Mar. 19	Mar. 21	None.	None.	0.10	4.30	0.50	3.80	.0000	.0039	.16	.0180	.0002
2234	Apr. 16	Apr. 17	Slight.	None.	0.20	3.80	0.70	3.10	.0000	.0036	.14	.0150	.0001
2422	May 14	May 15	None.	None.	0.30	4.00	1.00	3.00	.0000	.0074	.16	.0070	.0001
2596	June 12	June 13	Slight.	Slight.	0.45	3.45	0.95	2.50	.0028	.0068	.13	.0100	.0002
2789	July 17	July 18	None.	None.	0.15	4.35	0.80	3.55	.0004	.0108 .0068	.14	.0120	.0000
2937	Aug. 14	Aug. 15	Slight.	Very slight.	0.30	4.90	1.50	3.40	.0004	.0094 .0084	.17	.0070	.0002
3197	Sept. 17	Sept. 18	Very slight.	Very slight.	0.10	4.05	1.00	3.05	.0000	.0088 .0088	.18	.0120	.0003
3382	Oct. 16	Oct. 18	Very slight.	Very slight.	0.30	4.00	1.15	2.85	.0000	.0100 .0094	.16	.0100	.0001
Av.	....	....	....	....	0.25	4.53	0.80	3.73	.0005	.0078	.16	.0116	.0001

Hardness in May, 1888, 1.7. Odor, generally vegetable, occasionally mouldy. —— The samples were collected from a faucet in Clinton near the centre of the village.

Microscopical Examination.

	1888. June.	1888. July.	1888. August.	1888. Sept.	1888. Oct.
1. Blue-green Algæ, ...	0.1	0.0	0.0	0.0	0.0
2. Other Algæ, ...	1.2	0.2	0.1	0.4	0.2
3. Fungi, ...	0.3	0.0	pr.	0.0	0.0
4. Animal Forms, ...	0.4	0.6	0.1	0.1	pr.

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Diatomaceæ. 3. Schizomycetes. 4. Protozoa; Spongiaria; Rotifera; Entomostraca.

Chemical Examination of Water from the New Storage Reservoir, Clinton Water Works, Sterling.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance: Turbidity.	Appearance: Sediment.	Appearance: Color.	Residue on Evaporation: Total.	Residue on Evaporation: Loss on Ignition.	Residue on Evaporation: Fixed.	Ammonia: Free.	Ammonia: Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
3196	Sept. 17	Sept. 18	Slight.	Very slight.	0.15	5.70	1.20	4.50	.0020	.0110	.24	.0180	.0004

Odor, very faint or none.——The sample was collected from the new reservoir of the Clinton Water Works.

Microscopical Examination.

September, 1888. 1. Blue-green algæ, 0.0; 2. Other algæ, 0.0; 3. Fungi, 2.0; 4. Animal Forms, 0.0. Groups and principal genera of organisms observed: 3. Schizomycetes, *Crenothrix*.

Chemical Examination of Water from Heywood's Pond, Sterling.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance: Turbidity.	Appearance: Sediment.	Appearance: Color.	Residue on Evaporation: Total.	Residue on Evaporation: Loss on Ignition.	Residue on Evaporation: Fixed.	Ammonia: Free.	Ammonia: Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
2935	Aug. 14	Aug. 15	Distinct.	Slight.	0.30	3.25	1.65	1.60	.0000	.0190	.13	.0030	.0002

Odor, very faint or none.——The sample was collected from the brook flowing from Heywood's Pond at the first crossing of the highway below the pond.

Microscopical Examination.

August, 1888. 1. Blue-green algæ, 0.0; 2. Other algæ, 1.5; 3. Fungi, pr.; 4. Animal Forms, 1.8. Groups and principal genera of organisms observed: 2. Palmellaceæ; Diatomaceæ: Desmidiaceæ. 3. Schizomycetes. 4. Protozoa, *Peridinium;* Rotifera; Entomostraca.

Water Supply of Cohasset. — Cohasset Water Company.

Description of Works.—Population in 1885, 2,216. The works are owned by the Cohasset Water Company. Water was introduced in 1886. The source of supply is a system of tubular wells in a meadow along a brook. There are 63 wells, each 2 inches in diameter and 30 to 40 feet deep, driven into gravel. The strata passed through in going down from the surface were: 1 foot of muck, 2 feet of clay, 3 to 4 feet of sand and 10 to 18 feet of blue clay. Pumps force the water to an open distributing reservoir which has a capacity of 1,500,000 gallons. Water passes into the reservoir at one side and is drawn out at the other. The reservoir is 150 feet square on top

and contains 14 feet of water when full. The bottom is of concrete and the slopes are paved. Distributing mains are of cast iron and service pipes of wrought iron lined with cement.

Chemical Examination of Water from the Tubular Wells of the Cohasset Water Company.

[Parts per 100,000.]

Number.	Date of: Collection.	Date of: Examination.	Appearance: Turbidity.	Appearance: Sediment.	Appearance: Color.	Residue on Evaporation: Total.	Residue on Evaporation: Loss on Ignition.	Residue on Evaporation: Fixed.	Ammonia: Free.	Ammonia: Albuminoid.	Chlorine.	Nitrogen as: Nitrates.	Nitrogen as: Nitrites.
	1887.												
32	June 2	June 3	None.	Very slight.	0.00	11.97	–	–	.0034	.0025	1.76	.0390	–
267	July 6	July 7	None.	None.	0.00	13.60	–	–	.0002	.0010	1.77	.0200	–
470	Aug. 3	Aug. 4	None.	None.	0.00	14.50	–	–	.0000	.0016	1.74	.0130	–
750	Sept. 12	Sept. 13	Very slight.	Very slight.	0.00	15.20	–	–	.0000	.0012	1.75	.0200	–
1028	Oct. 24	Oct. 25	Very slight.	Very slight, earthy.	0.00	15.10	–	–	.0000	.0000	1.64	.0150	–
1164	Nov. 11	Nov. 12	None.	None.	0.00	17.20	–	–	.0000	.0022	1.60	.0180	–
1388	Dec. 11	Dec. 13	None.	None.	0.00	18.90	–	–	.0000	.0026	1.57	.0120	–
	1888.												
1548	Jan. 3	Jan. 6	None.	None.	0.00	16.70	–	–	.0000	.0014	1.63	.0200	.0010
1772	Feb. 6	Feb. 8	None.	None.	0.00	17.90	–	–	.0000	.0028	1.63	.0200	.0005
1979	Mar. 8	Mar. 9	Very slight, milky.	Slight, brown.	0.00	11.15	–	–	.0000	.0038	1.56	.0450	.0001
2160	Apr. 5	Apr. 6	Very slight.	None.	0.10	20.90	–	–	.0004	.0030	1.51	.0180	.0001
2416	May 14	May 15	None.	None.	0.00	13.70	–	–	.0000	.0014	1.66	.0400	.0003
2676	June 26	June 27	None.	None.	0.00	15.35	–	–	.0000	.0024	1.58	.0180	.0004
2798	July 18	July 19	None.	None.	0.00	17.70	–	–	.0002	.0016	1.46	.0200	.0001
2917	Aug. 11	Aug. 13	None.	None.	0.00	16.60	–	–	.0006	.0026	1.57	.0120	.0003
3238	Sept. 19	Sept. 22	Slight, milky.	Very slight.	0.00	17.60	–	–	.0000	.0014	1.66	.0350	.0004
3389	Oct. 17	Oct. 18	None.	None.	0.00	11.05	–	–	.0000	.0006	1.25	.0650	.0000
3595	Nov. 22	Nov. 24	None.	Very slight, earthy.	0.00	9.75	–	–	.0000	.0022	1.06	.0450	.0000
3755	Dec. 17	Dec. 20	None.	None.	0.00	13.95	–	–	.0002	.0020	1.46	.0350	.0008
	1889.												
3865	Jan. 17	Jan. 18	None.	None.	0.00	12.80	–	–	.0000	.0014	1.45	.0250	.0002
4121	Feb. 25	Feb. 26	None.	None.	0.00	14.80	–	–	.0000	.0028	1.54	.0000	.0006
4342	Mar. 20	Mar. 20	None.	None.	0.00	14.95	–	–	.0000	.0030	1.57	.0400	.0001
4465	Apr. 5	Apr. 5	None.	None.	0.00	9.80	–	–	.0004	.0020	1.37	.0300	.0001
4655	May 13	May 14	None.	None.	0.00	8.85	–	–	.0000	.0020	1.38	.0200	.0000
Av.	....	....	....	....	–	14.46	–	–	.0002	.0020	1.55	.0272	.0003

Hardness in June, 1887, 6.4; in May, 1888, 6.0. Odor, none.——The samples were collected from a faucet in the pumping station while pumping, with the exception of Nos. 32, 1979, 3389, 3595, 4342, 4465 and 4655, which were collected from a flowing tubular well near the wells used as sources of supply.

Microscopical Examination.

	1888.							1889.				
	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ, ...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	0.0	pr.	0.0	0.0	0.0	0.0	0.0	pr.	0.0	0.0	0.0	0.0
3. Fungi, ...	pr.	1.5	0.0	2.0	0.0	0.0	pr.	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, ...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	pr.	0.0

Groups and principal genera of organisms observed: 2. Zoosporeæ, Diatomaceæ. 3. Schizomycetes, *Leptothrix*. 4. Protozoa, Spongiaria.

Chemical Examination of Water from the Distributing Reservoir of the Cohasset Water Company.

[Parts per 100,000.].

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
29	June 2	June 3	Slight.	Very slight.	0.05	12.87	–	–	.0008	.0134	1.45	.0000	–
268	July 6	July 7	Very slight.	None.	0.00	12.75	–	–	.0003	.0090	1.65	.0000	–
469	Aug. 3	Aug. 4	Very slight.	None.	0.00	12.60	–	–	.0002	.0103	1.66	.0000	–
751	Sept. 12	Sept. 13	Decided.	Con., green.	0.05	15.40	–	–	.0000	.0128	1.69	.0070	–
1029	Oct. 24	Oct. 25	Decided.	Considerable, brown.	0.10	16.00	–	–	.0000	.0120	1.68	.0000	–
1165	Nov. 11	Nov. 12	Decided.	Con., green.	0.10	17.40	–	–	.0000	.0186	1.66	.0000	–
1387	Dec. 11	Dec. 13	Decided.	Con., green.	0.15	17.70	–	–	.0000	.0132	1.67	.0040	–
	1888.												
1547	Jan. 3	Jan. 6	Distinct.	Sli't, green.	0.20	18.00	–	–	.0000	.0140	1.66	.0020	.0000
1773	Feb. 6	Feb. 8	Slight.	Sli't, white.	0.00	18.95	–	–	.0002	.0112	1.69	.0100	.0004
1980	Mar. 8	Mar. 9	Slight.	None.	0.10	16.10	–	–	.0004	.0092	1.49	.0070	.0002
2159	Apr. 5	Apr. 6	Slight.	Very slight.	0.00	18.10	–	–	.0008	.0060	1.54	.0200	.0003
2417	May 14	May 15	Slight.	Very slight.	0.05	17.20	–	–	.0000	.0080	1.57	.0050	.0001
2675	June 25	June 27	Very slight.	Very slight.	0.00	16.60	–	–	.0000	.0110 .0094	1.55	.0020	.0001
2799	July 18	July 19	Very slight.	Very slight.	0.00	18.30	–	–	.0014	.0082 .0070	1.57	.0020	.0001
2918	Aug. 11	Aug. 13	Slight.	Considerable, brown.	0.00	18.50 17.90	–	–	.0000	.0064 .0030	1.64	.0080	.0001
3239	Sept. 19	Sept. 22	Distinct.	Slight, green.	0.00	17.40	–	–	.0000	.0132 .0074	1.54	.0020	.0005
3390	Oct. 17	Oct. 18	Distinct.	Considerable.	0.00	17.15 16.50	–	–	.0002	.0116 .0058	1.53	.0020	.0000
3596	Nov. 22	Nov. 24	Distinct.	Heavy, green.	0.00	17.10 16.50	–	–	.0000	.0160 .0064	1.49	.0040	.0001
3756	Dec. 17	Dec. 20	Distinct.	Considerable, green.	0.00	16.60	–	–	.0000	.0192 .0042	1.64	.0020	.0002

Chemical Examination of Water from the Distributing Reservoir of the Cohasset Water Company — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
3866	Jan. 17	Jan. 18	Distinct.	Very slight.	0.00	15.05 14.75	–	–	.0000	.0106 .0038	1.45	.0060	.0005
4122	Feb. 25	Feb. 26	Very slight.	Very slight, hair-like.	0.00	15.35	–	–	.0000	.0034 .0018	1.48	.0100	.0002
4343	Mar. 20	Mar. 20	Very slight.	None.	0.00	16.15	–	–	.0000	.0058 .0046	1.43	.0090	.0001
4466	Apr. 5	Apr. 5	Slight.	Very slight.	0.00	16.15	–	–	.0004	.0078	1.43	.0100	.0002
4656	May 13	May 14	Slight.	Slight.	0.03	16.70	–	–	.0014	.0126 .0076	1.47	.0020	.0003
Av.	....	....	....	....	0.03	16.32	–	–	.0003	.0110	1.57	.0048	.0002

Hardness in June, 1887, 5.6; in May, 1888, 8.8. Odor, generally none, occasionally mouldy and slightly disagreeable.—— The samples numbered 29, 268, 469, 751, 1029, 1165, 1387, 1547, 2159, 2675 and 2799 were collected from the reservoir. The remaining samples were collected from a faucet in the house nearest the reservoir, just before beginning to pump.

Microscopical Examination.

	1888. June.	1888. July.	1888. Aug.	1888. Sept.	1888. Oct.	1888. Nov.	1888. Dec.	1889. Jan.	1889. Feb.	1889. Mar.	1889. Apr.	1889. May.
1. Blue green Algæ, ...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	0.2	12.7	7.1	6.1	0.5	7.0	0.1	3.4	9.5	0.2	0.1	2.7
3. Fungi, ...	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, ...	pr.	1.2	0.0	pr.	pr.	pr.	8.0	0.0	pr.	pr.	pr.	0.5

Groups and principal genera of organisms observed: 2. Palmellaceæ; *Chlorococcus*, *Protococcus;* Zoosporeæ; Desmidiaceæ, *Closterium*, *Cosmarium;* Diatomaceæ, *Synedra*. 3. Schizomycetes. 4. Protozoa, *Trachelomonas;* Rotifera.

Chemical Examination of Water from the Brook near the Tubular Wells of the Cohasset Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
1163	Nov. 11	Nov. 12	Very slight.	Slight, brown.	0.7	10.70	3.23	7.47	.0012	.0357	2.37	.0100	–

Odor, very faint or none.—— The sample was collected from the brook.

Water Supply of Concord.

Description of Works. — Population in 1885, 3,727. The works are owned by the town, and were constructed in 1873. About 2,500 people were supplied in 1887. The source of supply is Sandy Pond in Lincoln, from which water is drawn at a point 280 feet from shore and $7\frac{1}{2}$ feet below high water. Area of pond, 150 acres. Drainage area, about 330 acres including the area of the pond. Water flows by gravity to the town and to a distributing reservoir. The area of this reservoir is about $\frac{3}{4}$ of an acre; depth at high water, $13\frac{1}{2}$ feet; capacity, 2,500,000 gallons. Its bottom is of concrete and the slopes are paved. Distributing mains are of cement-lined wrought iron. Service pipes are of lead and enameled iron.

The same source of supply is used by the towns of Concord and Lincoln.

Chemical Examination of Water from Sandy Pond in Lincoln.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
86	June 10	June 11	Decided.	Consid'ble, brown.	0.10	2.67	0.85	1.82	.0007	.0094	.24	.0070	-
307	July 11	July 12	Very slight.	Consid'ble, brown.	0.10	2.90	1.15	1.75	.0000	.0147	.20	.0030	-
530	Aug. 11	Aug. 12	Very slight.	Consid'ble, brown.	0.05	3.15	0.92	2.23	.0004	.0144	.27	.0000	-
760	Sept. 13	Sept. 14	Distinct.	Consid'ble, brown.	0.05	3.55	0.80	2.75	.0002	.0191	.23	.0030	-
974	Oct. 18	Oct. 19	Very slight.	Consid'ble, yellow.	0.00	2.75	0.80	1.95	.0000	.0123	.22	.0000	-
1166	Nov. 10	Nov. 12	Very slight.	Very slight.	0.00	2.27	0.45	1.82	.0000	.0124	.24	.0030	-
1393	Dec. 12	Dec. 14	Very slight.	None.	0.05	2.50	0.55	1.95	.0002	.0128	.29	.0020	-
	1888.												
1577	Jan. 11	Jan. 12	Slight.	Very slight.	0.00	2.00	0.60	1.40	.0000	.0148	.26	.0050	.0001
1787	Feb. 8	Feb. 10	Slight.	None.	0.00	2.50	0.75	1.75	.0000	.0132	.28	.0050	.0000
1989	Mar. 9	Mar. 10	Very slight.	Very slight.	0.00	2.50	0.60	1.90	.0000	.0100	.26	.0080	.0001
2205	Apr. 12	Apr. 13	Slight.	None.	0.00	2.45	0.60	1.85	.0000	.0114	.23	.0080	.0000
2395	May 10	May 10	Slight.	Very slight.	0.05	2.65	1.05	1.60	.0000	.0102	.22	.0050	.0001
Av.	....	....	....	....	0.03	2.66	0.76	1.90	.0001	.0129	.25	.0041	.0001

Hardness in May, 1888, 1.3. Odor very faint or none. —— The samples were collected from a faucet in the State Reformatory.

Microscopical Examination.

April, May, 1888. 1. Blue-green algæ, 0.0; 2. Other algæ, pr.; 3. Fungi, 0.0; 4. Animal forms, pr. Groups and principal genera of organisms observed: 2. Diatomaceæ. 4. Protozoa.

Ground Water Supply of the Massachusetts Reformatory, Concord.

The main water supply of the Reformatory is now obtained from the Concord Water Works, but it was formerly obtained from a system of tubular wells located near the Reformatory. These wells have been used as a source of supply at times during the summer as recently as 1888. There are 32 wells in all, $1\frac{1}{2}$ inches in diameter and 40 to 60 feet deep, sunk in the sandy tract of land between the wall surrounding the Reformatory and the Assabet River. The sewage from the Reformatory and from the dwellings of the officers is now disposed of by filtration through the sandy land on both sides and back of the wells and within a few hundred feet of them. The population at the Reformatory, including officers, is about 1,000, and the quantity of water used is approximately 100,000 gallons per day.

Chemical Examination of Water from the Tubular Wells at Concord Reformatory.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
306	July 11	July 12	None.	Slight.	0.0	18.40	-	-	.0036	.0019	2.81	.2600	-
529	Aug. 11	Aug. 12	None.	None.	0.0	15.30	-	-	.0006	.0016	2.27	.8450	-
761	Sept. 13	Sept. 14	None.	None.	0.0	19.40	-	-	.0002	.0020	2.39	1.300	-
925	Oct. 10	Oct. 11	None.	None.	0.0	16.95	-	-	.0000	.0026	2.74	.9700	-
	1888.												
2440	May 16	May 17	None.	None.	0.0	20.95	-	-	.0440	.0040	4.09	.7500	.0015
2441	May 17	May 17	Very slight, milky.	Slight, brown.	0.0	22.95	-	-	.0480	.0056	4.49	.7500	.0020
2530	May 29	May 29	None.	None.	0.0	22.65	-	-	.0770	.0036	4.75	.8000	.0022
2540	June 1	June 1	None.	None.	0.0	22.70	-	-	.0600	.0160	4.41	.7200	.0020
	1889.												
3904	Jan. 23	Jan. 23	None.	None.	0.0	19.15	-	-	.0042	.0024	3.10	.4250	.0004
3929	Jan. 25	Jan. 25	None.	None.	0.0	19.60	-	-	.0056	.0028	3.21	1.000	.0007
3945	Jan. 30	Jan. 30	None.	None.	0.0	21.20	-	-	.0020	.0044	3.40	1.600	.0007
3992	Feb. 7	Feb. 8	None.	None.	0.0	23.40	-	-	.0040	.0020	3.60	1.600	.0010
4025	Feb. 16	Feb. 16	None.	None.	0.0	20.20	-	-	.0036	.0022	3.20	1.200	.0012
Av.	....	....	....	....	0.0	20.22	-	-	.0194	.0039	3.42	.9400	.0013

Hardness in July, 1887, 4.9; in May, 1888, 7.6. Odor, faint, peculiar, sometimes like coal tar. —— The samples were collected from a faucet in the pumping station. The first group of samples (Nos. 306 to 925) were collected at regular monthly intervals while water was being pumped for the supply of the Reformatory. Nos. 2440 and 3904 were collected when pumping was resumed after the wells had been out of use for a long time. No. 2440 was collected May 16, 1888, at 3 P.M., and No. 2441 was collected May 17 at 7.30 A.M. No. 2530 was collected after pumping for about three weeks the amount necessary to supply the Reformatory. No. 2540 was collected after pumping 12 hours at the full capacity of the pumps. No. 3904 was collected after the pumps had been running for about 12 hours and 60,000 gallons of water had been drawn from the wells. No. 3929 was collected 60 hours after beginning to pump and after about 230,000 gallons had been drawn from the wells. No. 3945 was collected after 880,000 gallons had been drawn from the wells. Of this amount, 650,000 gallons were drawn after the collection of No. 3929.

Microscopical Examination.

	1888.				1889.				
	May 16.	May 17.	May 29.	June 1.	Jan. 23.	Jan. 25.	Jan. 30.	Feb. 7.	Feb. 16.
1. Blue-green Algæ, .	0.0	0.0	0.0	–	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, . . .	0.0	0.0	0.0	–	0.0	0.0	0.0	0.0	0.0
3. Fungi, ...	0.0	0.0	0.0	–	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, . .	0.0	0.0	0.0	–	0.0	0.0	0.0	pr.	0.0

Groups and principal genera of organisms observed: 4. Protozoa.

Chemical Examination of Water from Warner's Pond, Concord.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1889.												
4143	Feb. 27	Feb. 28	Very slight.	None.	0.7	4.60	1.90	2.70	.0010	.0204 .0174	.26	.0070	.0001

Odor, faintly vegetable.—— The sample was collected from the pond.

Water Supply of Dalton Fire District, Dalton.

Description of Works. — Population of the town in 1885, 2,113. The works are owned by the Fire District, and were constructed in 1884. About 225 families were supplied in 1887. The source of supply is Egypt Brook, on or near which a small storage reservoir is built. The reservoir is 200 feet square and 12 feet deep. Water is usually drawn from the brook above the reservoir, and the latter is kept in reserve. Water is distributed by gravity. Distributing mains are of cast iron and service pipes of galvanized iron.

Chemical Examination of Water from Egypt Brook.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Exam-ination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albu-minoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
55	June 7	June 9	None.	None.	0.15	2.57	1.07	1.50	.0003	.0076	.05	.0190	-
305	July 11	July 12	None.	None.	0.90	3.82	1.50	2.32	.0006	.0142	.10	.0000	-
478	Aug. 4	Aug. 5	None.	None.	0.40	3.17	0.95	2.22	.0004	.0064	.09	.0260	-
707	Sept. 7	Sept. 8	Very slight.	None.	0.15	2.35	0.60	1.75	.0002	.0076	.05	.0130	-
1324	Dec. 5	Dec. 6	None.	None.	0.10	2.50	0.75	1.75	.0000	.0050	.04	.0270	-
	1888.												
1990	Mar. 10	Mar. 12	Very slight.	None.	0.10	2.25	0.55	1.70	.0000	.0068	.08	.0400	-
2402	May 10	May 11	None.	None.	0.20	2.45	1.05	1.40	.0000	.0082	.05	.0120	.0001
Av.	....	....	....	....	0.29	2.73	0.92	1.81	.0002	.0080	.07	.0196	-

Hardness in May, 1888, 1.9. Odor, very faint or none.—The samples were collected from a faucet in the village.

Microscopical Examination.

May, 1888. An insignificant number of diatoms present.

Water Supply of Danvers.

Description of Works. — Population in 1885, 7,061. The works are owned by the town of Danvers. Water was introduced in 1876. The average daily consumption in 1888 was 463,700 gallons. The source of supply is Middleton Pond, also known as Forest Lake, in Middleton. Area of pond, 90 acres; general depth, 25 feet; maximum depth, 33 feet; bottom, sandy. In 1884 the pond was raised 2 feet by a dam built at the outlet. There are 30 acres of swamp bordering the pond. The drainage area, which is said to contain about 2,200 acres, is hilly and well-wooded. The soil is generally gravel. There is no population on the drainage area, and but very little cultivated land.

Pumps force the water from the pond to an open distributing reservoir. Area of reservoir, three-quarters of an acre; depth, 21 feet; capacity, 5,500,000 gallons. Its shape is irregular. It is surrounded by vertical stone walls and has a bottom of clay covered with gravel. Distributing mains and service pipes are of wrought iron lined with cement. The town was authorized to take the waters of Swan's Pond and to connect it with Middleton Pond, but the connection has not yet been built. Water is supplied by Danvers to a portion of the town of Middleton.

Chemical Examination of Water from Middleton Pond in Middleton.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
157	June 20	June 22	None.	Slight.	1.00	4.60	2.17	2.43	.0019	.0209	.38	.0130	–
368	July 20	July 20	Slight.	Slight.	0.90	4.02	1.57	2.45	.0002	.0155	.36	.0000	–
565	Aug. 17	Aug. 18	Very slight.	None.	0.50	4.52	1.12	3.40	.0002	.0178	.34	.0070	–
763	Sept. 14	Sept. 14	Slight.	Very slight.	0.30	4.30	1.42	2.88	.0002	.0210	.37	.0030	–
986	Oct. 18	Oct. 20	Very slight.	None.	0.40	4.25	0.95	3.30	.0000	.0178	.39	.0070	–
1202	Nov. 16	Nov. 17	Very slight.	Slight, earthy.	0.65	4.15	1.30	2.85	.0000	.0186	.34	.0030	–
1451	Dec. 19	Dec. 21	Very slight.	Very slight.	0.45	4.85	1.60	3.25	.0012	.0201	.47	.0050	–
	1888.												
1627	Jan. 17	Jan. 19	Very slight.	Very slight.	0.60	4.55	1.60	2.95	.0000	.0172	.31	.0070	–
1840	Feb. 15	Feb. 17	Very slight.	Very slight.	0.70	4.60	1.65	2.95	.0008	.0227	.41	.0120	.0001
2057	Mar. 19	Mar. 20	Slight.	Very slight.	0.80	4.55	1.35	3.20	.0004	.0207	.39	.0080	.0001
2246	Apr. 17	Apr. 19	Slight.	Very slight.	0.80	3.90	1.50	2.40	.0010	.0200	.33	.0050	.0002
2434	May 15	May 17	Very slight.	Very slight.	0.40	4.15	1.55	2.60	.0006	.0232	.34	.0030	.0001
2667	June 26	June 27	Very slight.	None.	1.10	3.90	1.55	2.35	.0028	.0210	.34	.0020	.0000
2783	July 17	July 18	Slight.	Very slight.	0.75	3.85	1.55	2.30	.0000	.0254 .0230	.32	.0020	.0001
2931	Aug. 14	Aug. 14	Slight.	Very slight.	0.50	3.75	1.55	2.20	.0000	.0222 .0196	.39	.0060	.0000
3210	Sept. 18	Sept. 19	Slight.	Very slight.	0.30	3.55	1.35	2.20	.0006	.0188 .0182	.33	.0030	.0002
3373	Oct. 16	Oct. 17	Very slight.	Slight.	0.50	3.80	1.45	2.35	.0004	.0214 .0178	.32	.0050	.0001
3580	Nov. 20	Nov. 21	Very slight.	Very slight.	0.80	4.10	1.80	2.30	.0012	.0248 .0216	.34	.0030	.0001
3707	Dec. 13	Dec. 14	Very slight.	Slight, earthy.	0.70	4.00	2.05	1.95	.0008	.0222 .0214	.37	.0030	.0001
	1889.												
3864	Jan. 17	Jan. 18	None.	Very slight.	0.30	2.85	0.90	1.95	.0016	.0134 .0134	.24	.0050	.0003
4092	Feb. 21	Feb. 23	Very slight.	Very slight.	0.45	4.05	1.30	2.75	.0040	.0146 .0124	.32	.0080	.0000
4338	Mar. 19	Mar. 20	Slight.	Slight.	0.70	3.65	1.50	2.15	.0000	.0362 .0184	.35	.0030	.0001
4521	Apr. 16	Apr. 17	Very slight.	Slight.	0.60	3.55	1.55	2.00	.0004	.0212 .0186	.32	.0020	.0001
4662	May 13	May 14	Slight.	Very slight.	0.70	3.75	1.55	2.20	.0010	.0198 .0172	.35	.0020	.0001
Av.	....	....	....	....	0.62	4.37	1.48	2.89	.0008	.0207	.35	.0049	.0001

Hardness in May, 1888, 1.3. Odor, very faint or none, occasionally faintly vegetable. —— The samples were collected from a faucet at the pumping station, while pumping, or from the pond. Sample No. 1451 was drawn through new cement-lined pipe. The level of Middleton Pond fluctuated 3.10 feet from January, 1888, to May, 1889. The highest points were reached in May, 1888, and March, 1889, and the lowest in September, 1888.

Microscopical Examination.

	1888.							1889.				
	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ, ...	0.2	pr.	0.1	0.2	pr.	pr.	pr.	0.0	0.0	0.0	0.0	pr.
2. Other Algæ, ...	0.5	10.1	20.5	8.8	6.0	17.6	23.9	15.8	53.0	62.0	19.4	1.2
3. Fungi, ...	pr.	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, ...	pr.	0.3	0.0	0.1	0.1	0.1	0.1	0.1	1.7	1.1	1.6	0.2

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ, *Chlorococcus:* Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Asterionella*, *Melosira*, *Stephanodiscus*, *Synedra*, *Tabellaria*. 3. Schizomycetes. 4. Protozoa, *Dinobryon;* Spongiaria; Rotifera; Entomostraca.

Chemical Examination of Water from the Danvers Distributing Reservoir.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
158	June 20	June 22	Slight.	Con.,brown	0.90	4.47	2.22	2.25	.0014	.0195	.39	.0060	–
369	July 20	July 21	Slight.	Slight.	0.70	4.32	1.40	2.92	.0002	.0201	.35	–	–
568	Aug. 17	Aug. 18	None.	None.	0.50	4.67	1.52	3.15	.0000	.0192	.36	.0000	–
969	Oct. 18	Oct. 19	Very slight.	Very slight.	0.90	4.30	1.20	3.10	.0000	.0241	.38	.0070	–
1201	Nov. 16	Nov. 17	Slight.	Very slight.	0.55	4.45	1.55	2.90	.0000	.0198	.40	.0050	–
1437	Dec. 19	Dec. 19	Very slight.	Slight.	0.70	4.85	1.65	3.20	.0000	.0186	.50	.0040	–
	1888.												
1616	Jan. 17	Jan. 18	Slight.	Very slight.	0.60	5.00	1.75	3.25	.0003	.0202	.34	.0070	–
1819	Feb. 14	Feb. 15	Very slight.	Very slight.	0.60	4.60	1.75	2.85	.0004	.0235	.43	.0090	.0000
2040	Mar. 19	Mar. 19	Very slight.	Sli't,brown.	0.70	4.80	1.50	3.30	.0008	.0190	.41	.0100	.0000
2235	Apr. 17	Apr. 18	Very slight.	Very slight.	0.60	4.20	1.25	2.95	.0000	.0202	.36	.0100	.0001
2457	May 18	May 18	Distinct.	Con.,brown	0.60	4.45	2.00	2.45	.0004	.0224	.32	.0050	.0001
Av.	....	....	....	....	0.67	4.56	1.62	2.94	.0003	.0206	.39	.0061	–

Hardness in May, 1888, 1.8. Odor, very faint or none, occasionally faintly vegetable. —— The samples were collected from a faucet in the town.

Microscopical Examination.

	1888.		
	March.	April.	May.
1. Blue-green Algæ, ...	0.0	0.0	pr.
2. Other Algæ, ...	pr.	pr.	pr.
3. Fungi, ...	0.0	0.0	0.0
4. Animal Forms, ...	pr.	pr.	pr.

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Diatomaceæ. 4. Protozoa; Rotifera; Entomostraca.

Chemical Examination of Water from Putnam's Pond, Danvers.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
4190	Mar. 2	Mar. 4	Slight.	Very slight.	0.2	8.90	2.25	6.65	.0030	.0186 .0122	1.53	.0800	.0010

Odor, musty and disagreeable. —— The sample was collected from the pond.

Water Supply of Dedham. — Dedham Water Company.

Description of Works. — Population in 1885, 6,641. The works are owned by the Dedham Water Company. Water was introduced in 1881. The average daily consumption in 1888 was 180,000 gallons. The source of supply is a well on the right bank of Charles River, just above the village. The well is situated about 40 feet from the river; it is 26 feet in diameter and 18 feet deep. The walls are of stone, lined inside with brick laid in cement. A cast-iron pipe 16 inches in diameter leads to a pump well 50 feet away. This well is 8 feet in diameter and 18 feet deep. Both wells are covered to exclude light. There is no direct connection between the wells and the river; but a connection has been made from the river to a large duplex pump for use in cases of emergency; it has been used once. Pumps force the water to an open iron tank 20 feet in diameter and 103 feet high. Distributing mains are of wrought iron lined with cement. Service pipes are of enameled iron.

Chemical Examination of Water from the Well of the Dedham Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
85	June 10	June 11	None.	None.	0.0	10.80	–	–	.0001	.0007	0.80	.1690	–
263	July 6	July 7	Slight.	None.	0.0	10.10	–	–	.0004	.0017	0.91	.1950	–
499	Aug. 8	Aug. 9	None.	None.	0.0	13.10	–	–	.0006	.0014	1.09	.3900	–
701	Sept. 7	Sept. 8	Very slight.	None.	0.0	11.75	–	–	.0000	.0009	1.05	.2600	–
1113	Nov. 7	Nov. 8	None.	None.	0.0	9.45	–	–	.0000	.0007	0.94	.3000	–
1371	Dec. 9	Dec. 10	None.	None.	0.0	10.60	–	–	.0000	.0016	1.01	.3000	–

Chemical Examination of Water from the Well of the Dedham Water Company — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
1551	Jan. 6	Jan. 7	None.	None.	0.0	10.30	–	–	.0000	.0012	0.99	.2700	.0000
1757	Feb. 6	Feb. 7	None.	None.	0.0	11.00	–	–	.0000	.0010	1.03	.2900	.0002
1955	Mar. 6	Mar. 7	None.	None.	0.0	10.10	–	–	.0002	.0014	0.82	.2500	.0000
2169	Apr. 9	Apr. 10	None.	None.	0.0	9.55	–	–	.0000	.0008	0.88	.2700	.0000
2396	May 9	May 10	Very slight.	None.	0.0	10.95	–	–	.0010	.0012	0.91	.3250	.0000
	1889.												
4583	Apr. 25	Apr. 27	None.	None.	0.0	9.15	–	–	.0000	.0020	0.93	.1700	.0000
Av.	....	....	....	....	0.0	10.57	–	–	.0002	.0012	0.95	.2658	–

Hardness in May, 1888, 4.5. Odor, none.——The samples were collected from a faucet at the pumping station while pumping.

Microscopical Examination.

	1888. Apr.	1888. May.	1889. Apr.
1. Blue-green Algæ,	0.0	0.0	0.0
2. Other Algæ,	pr.	pr.	0.1
3. Fungi,	0.0	0.0	0.0
4. Animal Forms,	0.0	0.0	0.0

Groups and principal genera of organisms observed: 2. Diatomaceæ.

DRACUT.

Chemical Examination of Water from Beaver Brook in Dracut.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
4721	May 22	May 23	Slight.	Consid'ble.	1.3	4.55	2.20	2.35	.0010	.0318 .0302	.13	.0030	.0002

Odor, very faintly vegetable.——The sample was collected from the brook at the dam of Parker & Bassett's paper mill. Water was running over the dam about six inches in depth, due to rains of May 20 and 21.

Microscopical Examination.

May, 1889. 1. Blue-green algæ, 0.0; 2. Other algæ, 0.3. Groups and principal genera of organisms observed: 2. Zoosporeæ; Diatomaceæ; Desmidiaceæ.

Water Supply of East Bridgewater.

This town is supplied jointly with Bridgewater by the Bridgewaters Water Company. *See Bridgewater.*

Eastham.

Chemical Examination of Water from Herring Pond in Eastham.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
2982	Aug. 18	Aug. 20	Slight.	Slight.	0.0	8.95	1.75	7.20	.0002	.0174 .0168	2.99	.0020	.0001

Odor, vegetable. —— The sample was collected from the pond.

Microscopical Examination.

August, 1888. 1. Blue-green algæ, 1.0; 2. Other algæ, 3.5; 3. Fungi, 0.0; 4. Animal forms, 0.1.
Groups and principal genera of organisms observed: 1. Cyanophyceæ, *Anabæna*. 2. Palmellaceæ, *Chlorococcus*; Zoosporeæ; Diatomaceæ, *Stephanodiscus*, *Tabellaria;* Desmidiaceæ. 4. Protozoa.

Chemical Examination of Water from Great Pond in Eastham.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
2983	Aug. 18	Aug. 20	Very slight.	Very slight.	0.0	6.80	2.15	4.65	.0004	.0172 .0168	1.98	.0000	.0001

Odor, vegetable. —— The sample was collected from the pond.

Microscopical Examination.

August, 1888. 1. Blue-green algæ, 0.0; 2. Other algæ, 0.1; 3. Fungi, 0.0; 4. Animal forms, 0.2.
Groups and principal genera of organisms observed: 2. Palmellaceæ. 4. Protozoa; Rotifera; Entomostraca.

Water Supply of Easthampton.

Description of Works. — Population in 1885, 4,291. The works are owned by the town. Water was introduced in 1870. The source of supply is a storage reservoir built in 1847 on a small stream which flows into Williston Pond. The area of this reservoir is about 2 acres; average depth, 8 feet; maximum depth, 15 feet. The drainage area contains very little population, and is generally cultivated land and pasture with a small amount of woodland. Water is pumped directly into the mains. Distributing mains are of cast iron, service pipes are of wrought iron.

Chemical Examination of Water from the Storage Reservoir of the Easthampton Water Works.

[Parts per 100,000.]

Number.	Date of — Collection.	Date of — Examination.	Appearance. — Turbidity.	Appearance. — Sediment.	Appearance. — Color.	Residue on Evaporation. — Total.	Residue on Evaporation. — Loss on Ignition.	Residue on Evaporation. — Fixed.	Ammonia. — Free.	Ammonia. — Albuminoid.	Chlorine.	Nitrogen as — Nitrates.	Nitrogen as — Nitrites.
	1887.												
189	June 22	June 24	Slight.	Slight.	0.20	4.87	0.87	4.00	.0014	.0135	.19	.0000	–
633	Aug. 26	Aug. 27	Distinct.	Slight.	0.90	5.55	1.95	3.60	.0033	.0332	.12	.0030	–
820	Sept. 19	Sept. 21	Distinct.	Slight.	0.25	4.65	0.80	3.85	.0023	.0166	.22	.0030	–
1252	Nov. 21	Nov. 23	Very slight.	None.	0.40	5.45	1.45	4.00	.0018	.0224	.35	.0150	–
1463	Dec. 20	Dec. 22	Slight.	Very slight.	0.20	4.70	1.00	3.70	.0034	.0171	.27	.0100	–
	1888.												
1684	Jan. 24	Jan. 26	Slight.	Slight.	0.05	4.50	0.65	3.85	.0034	.0054	.19	.0200	.0010
1875	Feb. 20	Feb. 21	None.	None.	0.15	4.35	0.70	3.65	.0005	.0078	.29	.0300	.0000
2056	Mar. 19	Mar. 20	Very slight.	None.	0.15	4.05	0.65	3.40	.0042	.0108	.24	.0200	.0005
2242	Apr. 17	Apr. 18	None.	Very slight.	0.15	2.90	0.70	2.20	.0000	.0133	.16	.0200	.0002
2488	May 21	May 22	Very slight.	None.	0.30	4.25	1.45	2.80	.0000	.0152	.13	.0200	.0000
2668	June 26	June 27	Decided.	Consid'ble.	0.90	5.15	1.80	3.35	.0144	.0428 .0304	.19	.0150	.0003
2835	July 24	July 25	Distinct.	Slight, green.	0.25	3.80	0.48	3.32	.0012	.0242 .0200	.34	.0020	.0002
3028	Aug. 23	Aug. 24	Very slight.	Slight.	0.40	4.70	1.20	3.50	.0000	.0180 .0160	.22	.0050	.0001
3223	Sept. 19	Sept. 20	Very slight.	Slight.	0.30	4.50	1.55	2.95	.0012	.0246 .0204	.31	.0050	.0001
3391	Oct. 17	Oct. 19	Very slight.	Very slight.	0.20	4.25	1.15	3.10	.0000	.0172 .0152	.18	.0100	.0003
3587	Nov. 21	Nov. 22	Distinct.	Heavy, red-brown.	0.30	3.75	1.10	2.65	.0008	.0190 .0126	.19	.0150	.0004
3734	Dec. 17	Dec. 19	Slight.	Slight.	0.10	4.10	0.80	3.30	.0020	.0082 .0058	.22	.0350	.0003
	1889.												
3885	Jan. 21	Jan. 22	Very slight, milky.	None.	0.15	3.45	0.70	2.75	.0014	.0136 .0132	.20	.0300	.0004
4126	Feb. 25	Feb. 27	Very slight.	Very slight.	0.10	3.65	0.80	2.85	.0010	.0108 .0086	.21	.0200	.0000
4367	Mar. 21	Mar. 22	Slight, milky.	Very slight.	0.15	3.35	0.45	2.90	.0000	.0114 .0098	.18	.0050	.0003
4540	Apr. 18	Apr. 19	Very slight.	Very slight.	0.10	4.00	0.70	3.30	.0006	.0140 .0126	.22	.0090	.0002
4672	May 15	May 16	Slight.	Very slight.	0.20	4.05	0.85	3.20	.0038	.0158 .0138	.21	.0150	.0005
Av.	....	....	....	....	0.27	4.53	1.02	3.51	.0021	.0170	.22	.0140	.0003

Hardness in May, 1888, 1.7. Odor, occasionally none, often vegetable and mouldy. —— The samples were collected from a faucet in the village, with the exception of Nos. 633, 820, 2668 and 2835, which were collected from the pond near the outlet. A very heavy shower occurred just before the collection of No. 2668.

Microscopical Examination.

	1888.							1889.				
	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ, ...	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	0.4	4.5	0.0	pr.	pr.	1.2	pr.	pr.	0.0	pr.	0.1	0.1
3. Fungi, ...	10.0	0.0	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, ...	pr.	15.4	0.0	pr.	0.0	0.2	pr.	0.0	0.0	0.0	0.0	pr.

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ, *Staurastrum;* Diatomaceæ. 3. Schizomycetes, *Crenothrix.* 4. Protozoa, *Trachelomonas;* Rotifera; Entomostraca.

Water Supply of North Easton Village District, Easton.

Description of Works. — Population in 1885, 3,948. The works are owned by the North Easton Village District. Water was introduced in 1887. The source of supply is a well near the Queset River west of the village. The well is 27 feet in diameter and 28 feet deep. Pumps force the water to a covered iron tank 20 feet in diameter and 103 feet high. Water is delivered near the top of the tank and drawn out at the bottom. Distributing mains are of cast iron and service pipes of enameled iron.

Chemical Examination of Water from the Well of the North Easton Village District.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1888.												
1918	Feb. 29	Mar. 1	Very slight.	None.	0.0	4.45	–	–	.0006	.0021	.40	.0350	.0001
2118	Mar. 28	Mar. 29	Distinct.	Very slight.	0.0	4.00	–	–	.0024	.0029	.37	.0230	.0001
2292	Apr. 23	Apr. 24	None.	Very slight.	0.0	3.45	–	–	.0004	.0016	40	.0200	.0001
2505	May 23	May 24	Very slight.	None.	0.0	4.05	–	–	.0000	.0010	.38	.0350	.0000
2751	July 10	July 11	None.	Very slight.	0.0	5.35	–	–	.0000	.0028	.54	.1000	.0001
2795	July 18	July 19	None.	Very slight.	0.0	5.15	–	–	.0002	.0008	.54	.0900	.0000
3001	Aug. 20	Aug. 21	None.	None.	0.0	5.25	–	–	.0000	.0024	.49	.0700	.0002
3220	Sept. 17	Sept 19	None.	None.	0.0	5.15	–	–	.0000	.0022	.52	.1200	.0000
3379	Oct. 16	Oct. 17	None.	None.	0.0	4.70	–	–	.0000	.0006	.43	.0800	.0000
3574	Nov. 19	Nov. 20	None.	None.	0.0	4.60	–	–	.0000	.0006	.41	.0850	.0001
3703	Dec. 12	Dec. 13	None.	None.	0.0	4.40	–	–	.0000	.0014	35	.0600	.0000

Chemical Examination of Water from the Well of the North Easton Village District — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
3862	Jan. 16	Jan. 17	None.	None.	0.0	3.70	–	–	.0000	.0020	.33	.0350	.0000
4043	Feb. 19	Feb. 20	None.	None.	0.0	3.50	–	–	.0000	.0012	.36	.0300	.0000
4341	Mar. 19	Mar. 20	None.	None.	0.0	3.75	–	–	.0000	.0012	.39	.0380	.0000
4520	Apr. 16	Apr. 17	None.	None.	0.0	3.45	–	–	.0000	.0022	.38	.0350	.0000
4664	May 14	May 15	None.	None.	0.0	3.60	–	–	.0000	.0006	.39	.0450	.0000
Av.	....	....	....	....	0.0	4.28	–	–	.0002	.0016	.42	.0563	–

Hardness in May, 1888, 1.7. Odor, none.——The samples were collected from the well or from a faucet in the pumping station while pumping. There were heavy rains just previous to the collection of No. 2118.

Microscopical Examination.

	1888. July.	1888. July.	1888. Aug.	1888. Sept.	1888. Oct.	1888. Nov.	1888. Dec.	1889. Jan.	1889. Feb.	1889. Mar.	1889. Apr.	1889. May.
1. Blue-green Algæ, ...	0.0	0.0	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	1.1	0.2	0.0	pr.	0.0	0.0	pr.	0.0	pr.	0.0	0.0	pr.
3. Fungi, ...	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, ...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Diatomaceæ. 3. Schizomycetes.

Water Supply of Everett.

Description of Works. — Population in 1885, 5,825. The works within the town are owned by the town, but water is supplied by the city of Boston from the Mystic Works. Water was introduced in 1867. In 1888 a high-service system was introduced. Water for this system is pumped from the low-service mains to an open iron tank 22 feet in diameter and 36 feet in height. Distributing mains are of wrought iron lined with cement, and of cast iron. Service pipes are of lead. For a description of the source of supply and analyses of the water, see *Boston, Mystic Works.*

Water Supply of Fall River.

Description of Works. — Population in 1885, 56,870. The works are owned by the city. Water was introduced in 1874. The average daily consumption in 1888 was 1,768,000 gallons. The source of supply is Watuppa Lake, which lies to the eastward of the main portion of Fall River, about $2\frac{1}{2}$ miles from the shore of Mount Hope Bay. Its greatest length is about 7.7 miles, in a noitherly and southerly direction, while its average width is less than three-fouiths of a mile and its greatest width $1\frac{1}{2}$ miles. At a point about half way between the northerly and southerly ends of the lake the shores approach each other, and a road and railroad cross it, thus dividing the lake into two sections. The Quequechan River, which is the outlet of the lake, flows from the northerly end of the southern section.

The northern section of the lake, from which the Fall River water supply is taken, is known as North Watuppa Lake, and has an area of 1,651 acres. The southerly section has an area of 1,827 acres. The total area of the lake is 3,478 acres, or 5.43 square miles. Its maximum depth is 30 feet. A survey of the entire lake in 1876 indicated that when the water is five feet below high-water mark, about 441 acres of the bottom of the pond are exposed which are covered at high-water mark. A previous survey in 1873 indicated that when the water was 4.5 feet below high-water mark, about 370 acres of the bottom were exposed. The shores of the south lake are generally quite bold, and there are only about 100 acres of shallow flowage. The shores of the north lake are not so bold, and there are several swamps which at high water are covered by only two or three feet of water. The total area of the swamps is about 110 acres.

The drainage area of about 31.25 square miles is generally hilly and contains no marshy lands or swamps. The soil is gravel, sand and rock. The population on the drainage area is very small, but there is danger that it may increase on the side of the lake next to the city.

Previous to 1885 the high and low service systems were distinct, and water for the supply of each was pumped from the lake to standpipes on a hill near the pumping station. These standpipes are of iron, and are 3.5 feet in diameter, The high-service pipe was 80 feet in height, and its high-water level was 325 feet above tide water. In 1885 an open iron storage tank was built in the extreme southern part of the city and the high and low service systems were connected, the height of the low-service standpipe being increased, thus making a single system. The storage tank is 37 feet high and 73 feet in diameter. Distributing mains are of cast iron; service pipes are of lead.

Chemical Examination of Water from North Watuppa Lake.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
161	June 21	June 22	None.	None.	0.30	3.37	1.25	2.12	.0023	.0143	.48	.0000	–
385	July 22	July 22	Very slight.	None.	0.25	3.20	0.77	2.43	.0004	.0154	.51	.0050	–
607	Aug. 23	Aug. 24	Very slight	None.	0.20	3.30	0.82	2.48	.0000	.0130	.48	.0070	–
811	Sept. 19	Sept. 20	Very slight.	Very slight.	0.00	3.25	0.90	2.35	.0004	.0185	.54	.0030	–
1020	Oct. 24	Oct. 25	Slight.	Very slight, white.	0.10	3.25	0.85	2.40	.0000	.0142	.55	.0020	–
1253	Nov. 22	Nov. 23	Very slight.	Very slight, white.	0.10	3.30	1.25	2.05	.0004	.0168	.63	.0070	–
1481	Dec. 23	Dec. 24	Slight, milky.	Very slight	0.15	3.15	1.00	2.15	.0000	.0138	.55	.0030	–
	1888.												
1672	Jan. 23	Jan. 24	Very slight.	Very slight.	0.10	3.50	1.00	2.50	.0000	.0144	.48	.0080	.0001
1863	Feb. 20	Feb. 20	Slight.	None.	0.10	3.25	1.05	2.20	.0020	.0184	.61	.0080	.0000
2073	Mar. 21	Mar. 22	Slight.	Very slight.	0.10	3.55	0.90	2.65	.0016	.0154	.54	.0030	.0000
2298	Apr. 24	Apr. 25	Slight.	Very slight.	0.25	2.80	1.00	1.80	.0011	.0163	.52	.0060	.0002
2487	May 22	May 22	Very slight.	Sli't, white.	0.10	3.20	1.00	2.20	.0000	.0146	.49	.0030	.0001
2674	June 26	June 27	Very slight.	Very slight.	0.30	3.25	1.15	2.10	.0002	.0194 .0158	.52	.0070	.0000
2855	July 26	July 27	None.	None.	0.30	2.85	0.55	2.30	.0000	.0168 .0168	.57	.0030	.0000
3027	Aug. 23	Aug. 24	Very slight	Very slight.	0.10	2.95	0.80	2.15	.0002	.0178 .0164	.46	.0050	.0000
3286	Sept. 29	Oct. 1	Slight.	Slight.	0.10	2.85	0.90	1.95	.0000	.0152 .0152	.49	.0050	.0001
3440	Oct. 25	Oct. 26	None.	Very slight.	0.20	3.20	0.90	2.30	.0000	.0150	.55	.0050	.0002
3620	Nov. 28	Nov. 30	Slight.	Slight.	0.10	3.40	1.00	2.40	.0000	.0184 .0172	.52	.0050	.0001
3777	Dec. 20	Dec. 21	Very slight.	Very slight.	0.30	3.35	0.95	2.40	.0000	.0184 .0148	.53	.0100	.0002
	1889.												
3923	Jan. 25	Jan. 25	Very slight.	Very slight.	0.20	3.20	1.40	1.80	.0002	.0176 .0144	.49	.0120	.0002
4181	Feb. 28	Mar. 1	Very slight.	Very slight.	0.30	3.50	1.50	2.00	.0004	.0180 .0152	.54	.0070	.0002
4438	Mar. 30	Mar. 30	Very slight.	None.	0.35	3.25	0.85	2.40	.0014	.0166 .0146	.50	.0090	.0004
4590	Apr. 29	Apr. 30	None.	None.	0.30	3.20	1.15	2.05	.0010	.0158 .0142	.49	.0070	.0002
4732	May 23	May 24	Very slight, milky.	Very slight.	0.20	3.35	1.10	2.25	.0000	.0140 .0116	.49	.0030	.0002
Av.	....	....	....	....	0.19	3.26	0.98	2.28	.0005	.0162	.52	.0055	.0001

Hardness in May, 1888, 0.6. Odor, faintly vegetable, often none.——The samples were collected from a faucet in the pumping station. Heavy rains occurred just previous to the collection of Nos. 385 and 607. The level of the water in the lake fluctuated but 2.1 feet from January, 1888, to May, 1889.

Microscopical Examination.

	1888.							1889.					
	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ,	0.0	pr.	0.0	0.0	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ,	pr.	0.0	0.1	0.0	0.0	0.3	0.8	0.4	0.6	1.7	0.1	pr.
3. Fungi,	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms,	pr.	pr.	0.0	0.0	pr.	0.0	0.0	0.0	2.5	3.0	0.0	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Tabellaria;* Zygnemaceæ. 4. Protozoa, *Dinobryon;* Spongiaria; Rotifera; Entomostraca.

Chemical Examination of Water from a faucet in Fall River.

[Parts per 100,000.]

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.
	1887.												
162	June 21	June 22	Slight.	Slight.	0.3	3.47	1.45	2.02	.0010	.0139	.53	.0000	–

Odor, very faint or none. —— The sample was collected from a faucet in the water works repair shop in the city.

Water Supply of Fitchburg.

Description of Works. — Population in 1885, 15,375. The works are owned by the city. Water was introduced in 1872. The average daily consumption in 1888 was 1,300,000 gallons. The sources of supply are Scott and Falulah brooks, on each of which a storage reservoir is built. Scott Reservoir was built in 1878 and is at an elevation of 450 feet above the city base (the railroad track near the Fitchburg station). Its area is 35.07 acres; depth near the gate-house, 40 feet; bottom, sandy; capacity, 210,000,000 gallons. There is very little shallow flowage. Its drainage area of 600 acres is very steep and rocky, with little woodland or cultivated land. Much of the area is used for pasturage, and it contains very few inhabitants. From Scott Reservoir a 24-inch brick conduit conveys the water to Overlook Distributing Reservoir, one and one-half miles nearer the city. Overlook Reservoir was formed by building dams at each end of a ravine. It was built in 1871, and its elevation is 400 feet above the city base. Its area is 13 acres; depth, 40 feet; bottom, gravel; capacity, 60,000,000 gallons. There is no shallow flowage. Its immediate drainage area is very small, being estimated at 10 acres. Water is supplied directly from this reservoir to the high-service dis-

tricts. About 1,000 feet nearer the city is a second distributing reservoir, known as the Marshall Reservoir, which is at an elevation of 212 feet above the city base. Its area is about half an acre, and its capacity is 1,000,000 gallons. The bottom and slopes are paved. Water is supplied from this reservoir to the low-service district. In 1873 an additional supply of water became necessary, and a 14-inch cement-lined wrought-iron pipe was laid from a point just above Shattuck's Mill Pond on Falulah Brook to the conduit between Scott and Overlook reservoirs, and at the present time water can be drawn into Overlook from either Scott Reservoir or Shattuck Brook, or from both. In 1881 a small reservoir was built just below the dam of the Scott Reservoir, to catch the leakage from the latter and divert it into the conduit leading to Overlook Reservoir.

Another reservoir was built in 1883 at the junction of Scott and Falulah brooks. This reservoir, known as Falulah Reservoir, receives the water from Scott Brook, including that from the overflow and waste gates of Scott Reservoir, and also the water of Falulah Brook, including the overflow and waste from Shattuck's Mill Pond. Falulah Reservoir is at an elevation of 235 feet above the city base. Its area is 3.75 acres; depth at dam, 20 feet; average depth, 10 feet; bottom, gravel; capacity, 20,000,000 gallons. There is very little shallow flowage. Its drainage area of 2,227 acres, exclusive of that of Scott Reservoir, is similar in all respects to the drainage area of that reservoir. Since the storage capacity of Falulah Reservoir is small in comparison with the extent of its drainage area, the water in it must change entirely at short intervals in a year of average rainfall; this is in great contrast to Scott Reservoir, which has a drainage area of but a little more than one-fourth that of Falulah, while its storage capacity is more than ten times as great. A 16-inch pipe from Falulah Reservoir is laid to the city and connected with the low-service system, so that Marshall Reservoir, being at a slightly less elevation than Falulah, is now supplied from the latter during the greater part of the year. When necessary, however, water can be diverted into Marshall from Overlook Reservoir. Distributing mains are of cast iron and of wrought iron lined with cement, there being about the same number of miles of each, but the cement-lined mains are being replaced with cast iron. Service pipes are of wrought iron lined with cement. The report of the Water Commissioners for 1878 mentions that numerous complaints of a fishy odor and taste in the water were made in August of that year. A similar trouble has occurred several times since that year, but has lasted only a few days at a time.

Chemical Examination of Water from Scott Reservoir, Fitchburg.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
212	June 28	June 29	Slight.	Slight.	0.30	2.75	1.07	1.68	.0004	.0192	.15	.0020	–
420	July 27	July 28	Slight.	Slight.	0.40	2.55	0.97	1.58	.0006	.0195	.14	.0040	–
639	Aug. 29	Aug. 30	Slight.	None.	0.35	2.52	1.10	1.42	.0002	.0190	.15	.0030	–
836	Sept. 21	Sept. 22	Very slight.	Slight.	0.28	2.50	1.00	1.50	.0003	.0185	.13	.0000	–
1054	Oct. 26	Oct. 27	Slight.	Consid'ble, brown.	0.20	2.85	0.80	2.05	.0003	.0322	.15	.0000	–
1274	Nov. 29	Nov. 30	Decided.	Much, white.	0.25	2.45	1.00	1.45	.0003	.0272	.18	.0020	–
1499	Dec. 28	Dec. 29	Very slight.	Considerable.	0.30	2.80	1.15	1.65	.0026	.0262	.14	.0040	–
	1888.												
1713	Jan. 31	Feb. 1	Very slight.	Slight.	0.10	2.85	1.10	1.75	.0014	.0245	.13	.0090	.0000
1906	Feb. 27	Feb. 29	Distinct.	Slight.	0.20	2.75	1.05	1.70	.0003	.0357	.12	.0030	.0000
2106	Mar. 26	Mar. 27	Distinct.	None.	0.15	2.30	0.75	1.55	.0000	.0212	.19	.0050	.0000
2320	Apr. 26	Apr. 27	Distinct.	Very slight.	0.10	1.70	0.45	1.25	.0000	.0092	.10	.0100	.0001
2534	May 28	May 29	Decided.	Slight.	0.15	2.20	0.60	1.60	.0000	.0176	.12	.0010	.0001
2658	June 21	June 23	Distinct.	Consid'ble, green.	0.10	1.95	0.60	1.35	.0004	.0202 .0152	.14	.0020	.0001
2787	July 17	July 18	Decided.	Consid'ble, green.	0.10	2.25	0.90	1.35	.0000	.0262 .0176	.13	.0020	.0001
3016	Aug. 22	Aug. 23	Distinct.	Con., light yellow.	0.10	2.30	0.85	1.45	.0008	.0386 .0208	.11	.0020	.0000
3271	Sept. 25	Sept. 27	Distinct.	Consid'ble, green.	0.10	2.30	0.95	1.35	.0000	.0272 .0208	.11	.0020	.0001
3443	Oct. 24	Oct. 26	Distinct.	Consid'ble, white.	0.10	2.20	0.85	1.35	.0020	.0244 .0178	.15	.0050	.0002
3611	Nov. 26	Nov. 27	Slight.	Consid'ble, green.	0.05	2.25	0.65	1.60	.0000	.0268 .0156	.15	.0040	.0002
3741	Dec. 17	Dec. 19	Slight.	Very slight.	0.05	2.70	0.75	1.95	.0000	.0158 .0124	.14	.0030	.0001
	1889.												
3941	Jan. 28	Jan. 29	Slight.	None.	0.05	1.90	0.50	1.40	.0000	.0208 .0110	.12	.0030	.0002
4176	Feb. 27	Mar. 1	Slight.	Slight.	0.10	2.45	0.55	1.90	.0004	.0086 .0072	.14	.0060	.0002
4422	Mar. 26	Mar. 28	Very slight.	Very slight.	0.15	2.05	0.60	1.45	.0012	.0162 .0130	.14	.0030	.0001
4578	Apr. 25	Apr. 26	Distinct.	Consid'ble, white.	0.05	2.25	0.70	1.55	.0008	.0260 .0182	.12	.0040	.0002
4708	May 21	May 22	Distinct.	Con., green and floc'nt.	0.10	1.95	0.75	1.20	.0012	.0222 .0154	.15	.0020	.0000
Av.	....	....	....	....	0.16	2.52	0.92	1.60	.0006	.0226	.14	.0034	.0001

Hardness in May, 1888, 0.5. Odor, generally very faint or none, sometimes very faintly vegetable, rarely disagreeable. —— The samples were collected from the reservoir at the gate-house at a depth of about one foot beneath the surface, with the exception of No. 4176, which was collected from the north end of the reservoir and distant from the dam. For a record of heights of water in this reservoir at the times when the samples of water were collected, see page 128.

Microscopical Examination.

	1888.							1889.				
	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ, ...	0.0	0.6	1.3	pr.	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	15.1	4.8	6.4	11.7	6.7	0.0	2.5	pr.	4.2	0.1	pr.	1.5
3. Fungi, ...	0.0	0.0	pr.	0.0	0.0	0.0	0.0	0.0	pr.	0.0	0.0	0.0
4. Animal Forms, ...	pr.	0.6	1.3	pr.	pr.	0.0	0.0	3.3	0.4	pr.	0.0	0.1

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ, *Chlorococcus;* Zoosporeæ; Desmidiaceæ, *Staurastrum;* Diatomaceæ, *Asterionella, Synedra, Tabellaria;* Zygnemaceæ; Volvocineæ. 3. Schizomycetes. 4. Protozoa, *Peridinium;* Rotifera; Entomostraca.

Chemical Examination of Water from Overlook Reservoir, Fitchburg.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
210	June 28	June 29	Slight.	Very slight.	0.00	2.27	0.50	1.77	.0002	.0059	.15	.0000	–
421	July 27	July 28	Very slight.	Slight.	0.00	2.12	0.22	1.90	.0000	.0069	.17	.0000	–
641	Aug. 29	Aug. 30	Slight.	Slight.	0.00	2.42	0.42	2.00	.0004	.0099	.13	.0000	–
835	Sept. 21	Sept. 22	Very slight.	Slight.	0.00	2.65	0.40	2.25	.0003	.0106	.14	.0000	–
1053	Oct. 26	Oct. 27	Slight.	Consid'ble.	0.10	2.75	0.60	2.15	.0002	.0124	.14	.0020	–
1273	Nov. 29	Nov. 30	Decided.	Slight.	0.10	2.45	0.55	1.90	.0000	.0155	.19	.0010	–
1498	Dec. 28	Dec. 29	Distinct.	Slight.	0.10	2.85	0.55	2.30	.0009	.0226	.15	.0020	–
	1888.												
1712	Jan. 31	Feb. 1	Distinct.	None.	0.35	3.25	1.10	2.15	.0028	.0264	.10	.0090	.0000
1905	Feb. 27	Feb. 29	Slight.	Very slight.	0.00	2.00	0.45	1.55	.0122	.0193	.16	.0060	.0001
2105	Mar. 26	Mar. 27	Slight.	Consid'ble, brown.	0.10	2.40	0.45	1.95	.0036	.0227	.16	.0050	.0001
2321	Apr. 26	Apr. 27	Distinct.	Slight.	0.10	1.80	0.20	1.60	.0000	.0084	.12	.0150	.0003
2533	May 28	May 29	Distinct.	Very slight.	0.05	1.90	0.40	1.50	.0000	.0070	.09	.0010	.0001
2657	June 21	June 23	Very slight.	Very slight, white.	0.10	2.10	0.50	1.60	.0004	.0146 .0124	.11	.0020	.0001
2786	July 17	July 18	Slight.	Very slight.	0.10	2.40	0.70	1.70	.0000	.0196 .0158	.10	.0090	.0000
3015	Aug. 22	Aug. 23	Distinct.	Slight, white.	0.10	3.50	0.90	2.60	.0000	.0180 .0146	.13	.0000	.0000
3270	Sept. 26	Sept. 27	Slight.	Considerable.	0.20	2.50	0.95	1.55	.0000	.0174 .0148	.12	.0020	.0001
3444	Oct. 24	Oct. 26	Slight.	Very slight.	0.20	2.40	0.90	1.50	.0008	.0174 .0160	.13	.0060	.0002
3610	Nov. 26	Nov. 27	Slight.	Consid'ble, green.	0.00	2.25	0.50	1.75	.0000	.0172 .0114	.13	.0070	.0002
3740	Dec. 17	Dec. 19	Very slight.	Con., dark brown.	0.20	2.35	0.70	1.65	.0004	.0150 .0078	.07	.0080	.0001

Chemical Examination of Water from Overlook Reservoir — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
3043	Jan. 28	Jan. 29	Very slight.	Slight.	0.00	2.00	0.45	1.55	.0000	.0092 .0062	.10	.0040	.0002
4175	Feb. 27	Mar. 1	Very slight, milky.	Slight.	0.20	2.50	0.45	2.05	.0038	.0122 .0096	.13	.0070	.0001
4421	Mar. 26	Mar. 28	Very slight.	Slight.	–	2.05	0.55	1.50	.0006	.0144	.07	.0060	.0001
4577	Apr. 25	Apr. 26	Slight.	Slight, white.	0.10	1.95	0.45	1.50	.0008	.0222 .0178	.10	.0040	.0003
4707	May 21	May 22	Very slight.	Very slight.	0.20	2.20	0.65	1.55	.0010	.0184 .0180	.14	.0020	.0001
Av.	....	....	....	....	0.10	2.41	0.49	1.92	.0012	.0151	.13	.0041	.0001

Hardness in May, 1888, 0.6. Odor, generally very faint or none, sometimes very faintly vegetable, rarely disagreeable.—— The samples were collected from the reservoir at the gate-house at the south dam, with the exception of No. 4421, which was collected at the north dam. Nos. 210, 421, 641, 835, 2321 and 2533 were collected from about five feet beneath the surface, the remaining samples one foot beneath the surface. A fishy taste and odor were complained of at the time of collecting No. 2657. For a record of the heights of water in this reservoir at the times when the samples of water were collected, see page 128.

Microscopical Examination.

	1888. June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	1889. Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ, ...	pr.	pr.	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	1.3	1.4	3.1	1.7	5.2	10.3	2.7	0.0	0.2	0.6	0.6	2.0
3. Fungi, ...	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, ...	2.0	pr.	0.2	1.0	0.0	0.0	pr.	0.0	pr.	0.6	0.0	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ, *Staurogenia;* Desmidiaceæ; Diatomaceæ, *Asterionella*, *Melosira*, *Tabellaria;* Volvocineæ. 3. Schizomycetes. 4. Protozoa, *Dinobryon;* Rotifera; Spongiaria; Entomostraca.

Chemical Examination of Water from Falulah Reservoir, Fitchburg.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
211	June 28	June 29	Very slight.	Very slight.	0.70	3.30	1.35	1.95	.0002	.0162	.11	.0060	–
419	July 27	July 28	Very slight.	Slight.	0.90	3.40	0.87	2.53	.0005	.0183	.11	.0040	–
640	Aug. 29	Aug. 30	Very slight.	None.	0.40	2.67	0.85	1.82	.0002	.0119	.11	.0030	–

Chemical Examination of Water from Falulah Reservoir — Concluded.

Number.	Date of Collection.	Date of Exam-ination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albu-minoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
834	Sept. 21	Sept. 22	Slight.	Slight.	0.20	2.90	0.70	2.20	.0006	.0134	.13	.0000	–
1052	Oct. 26	Oct. 27	Very slight.	Slight.	0.30	3.15	0.85	2.30	.0002	.0160	.24	.0030	–
1272	Nov. 29	Nov. 30	Distinct.	Slight.	0.30	2.65	0.90	1.75	.0005	.0221	.18	.0030	–
1497	Dec. 28	Dec. 29	Very slight.	Very slight.	0.15	2.60	0.65	1.95	.0012	.0171	.12	.0080	–
	1888.												
1711	Jan. 31	Feb. 1	Very slight.	Very slight.	0.15	2.65	0.65	2.00	.0010	.0156	.10	.0100	.0000
1904	Feb. 27	Feb. 29	Distinct.	Considera-ble, earthy.	0.10	3.00	1.10	1.90	.0076	.0350	.10	.0070	.0000
2104	Mar. 26	Mar. 27	Very slight.	Very slight.	0.25	1.95	0.40	1.55	.0000	.0138	.14	.0050	.0000
2319	Apr. 26	Apr. 27	Slight.	Very slight.	0.30	1.80	0.55	1.25	.0000	.0075	.08	.0030	.0001
2532	May 28	May 29	Slight.	Slight.	0.10	2.15	0.60	1.55	.0000	.0092	.09	.0020	.0001
2656	June 21	June 23	Distinct.	Considera-ble.	0.30	2.50	0.95	1.55	.0008	.0222 .0154	.08	.0030	.0001
2785	July 17	July 18	Decided.	Considera-ble, green.	0.20	2.60	0.80	1.80	.0000	.0316 .0194	.08	.0000	.0001
3014	Aug. 22	Aug. 23	Distinct.	Slight, green.	0.30	3.35	1.15	2.20	.0000	.0266 .0184	.10	.0050	.0000
3269	Sept. 26	Sept. 27	Slight.	Slight, white.	0.20	2.95	1.40	1.55	.0000	.0268 .0196	.14	.0030	.0002
3442	Oct. 24	Oct. 26	Slight.	Slight, white.	0.45	2.55	0.75	1.80	.0004	.0152 .0138	.14	.0030	.0002
3609	Nov. 26	Nov. 27	Slight.	Considera-ble, earthy.	0.05	2.30	0.50	1.80	.0002	.0198 .0168	.14	.0050	.0003
3739	Dec. 17	Dec. 19	Distinct.	Slight, earthy.	0.20	2.40	0.65	1.75	.0004	.0148 .0110	.13	.0030	.0002
	1889.												
3942	Jan. 28	Jan. 29	Very slight.	Very slight.	0.05	2.15	0.55	1.60	.0000	.0150 .0120	.11	.0040	.0002
4174	Feb. 27	Mar. 1	None.	Very slight.	0.10	2.45	0.45	2.00	.0002	.0062 .0048	.11	.0090	.0001
4420	Mar. 26	Mar. 28	Very slight.	Very slight.	0.15	1.95	0.55	1.40	.0014	.0172 .0138	.07	.0050	.0001
4576	Apr. 25	Apr. 26	Distinct.	Slight, white.	0.10	2.05	0.30	1.75	.0008	.0192 .0144	.08	.0030	.0002
4706	May 21	May 22	Slight.	Considera-ble, earthy.	0.75	2.75	1.20	1.55	.0024	.0224 .0204	.09	.0040	.0001
Av.	....	....	....	....	0.28	2.74	0.82	1.92	.0008	.0180	.12	.0042	.0001

Hardness in May, 1888, 0.6. Odor, generally very faint or none, sometimes very faintly vegetable, rarely disagreeable. —— The samples were collected from the reservoir at the gate-house, with the exception of No. 4174, which was collected at the inlet to the reservoir. Nos. 211, 419, 640, 834, 2319 and 2532 were collected at a depth of five feet beneath the surface, and the remaining samples at one foot beneath the surface. On account of a bad odor and taste, this reservoir was shut off on July 7, 1888, and no water was being used from it at the time of collecting Nos. 2785 and 3014. For a record of the heights of water in this reservoir at the times when the samples of water were collected, see page 128.

Microscopical Examination.

	1888.							1889.					
	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ,	0.0	pr.	0.0	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ,	0.4	7.1	0.4	0.3	0.7	1.4	11.8	0.1	0.1	3.1	1.2	0.9
3. Fungi,	0.2	0.0	0.0	pr.	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms,	0.3	20.0	1.1	pr.	0.2	0.0	0.3	pr.	0.0	0.0	12.0	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ, *Scenedesmus;* Desmidiaceæ; Diatomaceæ, *Asterionella, Gomphonema, Synedra, Tabellaria.* 3. Schizomycetes. 4. Protozoa, *Dinobryon, Peridinium*; Rotifera.

Heights of Water in Falulah, Overlook and Scott Reservoirs, Fitchburg, at the times when Samples of Water were collected for Analysis.

Note. — The height of water in Falulah Reservoir, when full, is 20 feet; in Overlook and Scott Reservoirs, 40 feet.

Date of Collection of Samples of Water.	Height of Water in Reservoirs.		
	Falulah.	Overlook.	Scott.
1887.			
June 28,	20.0	38.0	40.0
July 27,	20.0	37.4	39.5
August 29,	20.0	37.0	40.0
September 21,	20.0	37.1	40.0
October 26,	7.0	38.0	39.3
November 29,	20.0	36.0	39.5
December 28,	20.0	35.0	40.0
1888.			
January 31,	18.0	39.5	40.0
February 27,	20.2	38.5	40.1
March 26,	20.1	36.0	40.05
April 26,	20.2	37.6	40.05
May 28,	20.05	38.55	40.0
June 21,	19.5	39.5	39.8
July 17,	19.2	36.3	39.3
August 22,	20.2	34.0	36.0
September 26,	20.5	37.6	35.5
October 24,	20.4	37.6	39.2
November 26,	20.2	35.0	40.05
December 17,	20.6	33.4	40.4
1889.			
January 28,	20.1	39.4	40.05
February 27,	19.5	37.0	39.9
March 26,	20.1	39.5	40.05
April 25,	19.7	38.7	39.9
May 21,	19.6	39.7	39.9

Water Supply of Framingham. — Framingham Water Company.

Description of Works. — Population of the town in 1885, 8,275. The works are owned by the Framingham Water Company. Water was introduced in 1885, and is now supplied to the village of South Framingham only. The average daily consumption for 1888 was 170,000 gallons. The source of supply is a filter-gallery on the shore of Farm Pond. The gallery is in two sections, one section being 200 feet long and the other 250 feet with a pump well between. Each section is about 4 feet high and 42 to 48 inches wide. The pond covers part of the gallery, and in some places there is a thickness of but two feet of gravel between the top of the arch and the water above. The arch is water-tight, however, and no water can reach the gallery unless it has passed through at least five feet of filtering material. The bottom of the filter-gallery is about six feet below the surface of the pond. There is a direct connection between the pump well and Farm Pond, and also a connection with the conduit leading from the Sudbury River reservoirs of the Boston Water Works, made by a pipe laid on the bottom of the pond to the conduit. Water is distributed by pumping directly to the consumers. Distributing mains are of cast iron, and service pipes of lead and wrought iron.

Chemical Examination of Water from the Filter-Gallery of the Framingham Water Company.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1887.												
204	June 27	June 28	None.	Very slight.	0.20	5.27	0.77	4.50	.0010	.0080	.41	.0260	–
403	July 26	July 27	None.	Considerable, black.	0.15	5.45	0.57	4.88	.0008	.0098	.37	.0130	–
645	Aug. 30	Aug. 31	Very slight.	None.	0.10	6.27	0.80	5.47	.0060	.0268	.56	.0070	–
874	Oct. 3	Oct. 4	Very slight.	Considerable, earthy.	0.05	5.65	0.92	4.73	.0051	.0159	.40	.0100	–
1089	Nov. 1	Nov. 2	Very slight.	Slight.	0.00	5.80	0.90	4.90	.0006	.0064	.41	.0100	–
1309	Dec. 2	Dec. 3	Slight.	None.	0.00	6.45	0.85	5.60	.0052	.0072	.40	.0080	–

Chemical Examination of Water from the Filter-Gallery of the Framingham Water Company — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
1524	Jan. 2	Jan. 3	Very slight.	Slight.	0.00	6.05	0.75	5.30	.0030	.0065	.44	.0200	.0001
1719	Feb. 1	Feb. 1	Very slight.	None.	0.00	5.70	0.85	4.85	.0022	.0044	.38	.0200	.0001
1941	Mar. 2	Mar. 3	None.	None.	0.00	6.10	0.80	5.30	.0034	.0061	.47	.0300	.0004
2135	Apr. 2	Apr. 3	Very slight.	None.	0.00	5.65	0.60	5.05	.0008	.0028	.46	.0400	.0001
2329	May 1	May 1	Distinct.	Very slight.	0.10	5.60	0.75	4.85	.0010	.0048	.47	.0300	.0002
2552	June 6	June 6	None.	Very slight.	0.15	6.12	0.88	5.24	.0012	.0102 .0058	.50	.0320	.0003
2711	July 5	July 5	Distinct.	Slight, earthy.	0.10	6.00	1.55	4.45	.0048	.0126 .0110	.45	.0280	.0005
2861	Aug. 1	Aug. 2	None.	Very slight.	0.40	5.70	1.30	4.40	.0020	.0176 .0148	.38	.0080	.0007
3053	Sept. 4	Sept. 5	None.	Very slight.	0.30	5.05	1.20	3.85	.0046	.0108	.29	.0060	.0004
3287	Oct. 1	Oct. 2	Very slight.	Slight, black.	0.05	5.90	1.10	4.80	.0036	.0128 .0100	.44	.0500	.0007
3483	Oct. 31	Nov. 1	Very slight.	None.	0.10	5.80	1.20	4.60	.0030	.0058	.46	.0300	.0003
3641	Dec. 3	Dec. 4	Very slight, milky.	None.	0.00	6.05	1.05	5.00	.0024	.0026	.53	.0750	.0004
	1889.												
3811	Jan. 1	Jan. 2	Very slight.	None.	0.00	6.15	1.20	4.95	.0022	.0060	.60	.0800	.0001
3966	Feb. 4	Feb. 5	Distinct, milky.	Slight, white.	0.00	5.40	0.30	5.10	.0036	.0050	.48	.0400	.0002
4209	Mar. 4	Mar. 5	None.	None.	0.00	6.55	1.40	5.15	.0058	.0050	.48	.0100	.0001
4452	Apr. 1	Apr. 2	None.	None.	0.00	6.40	1.10	5.30	.0050	.0032	.50	.0280	.0001
4607	May 1	May 2	None.	None.	0.00	6.40	1.35	5.05	.0044	.0038	.52	.0250	.0001
Av.	....	....	....	....	0.07	5.93	0.90	5.03	.0031	.0084	.45	.0272	.0003

Hardness in May, 1888, 3.0. Odor, very faint or none.——The samples were collected from the filter-gallery.

Microscopical Examination.

	1888. June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	1889. Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ, ...	0.0	0.0	0.0	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	pr.	0.0	0.0	0.0	0.0	0.0	pr.	pr.	0.0	0.0	0.0	0.0
3. Fungi, ...	1.0	3.2	0.0	pr.	pr.	0.0	0.2	0.0	0.0	0.0	pr.	0.0
4. Animal Forms, ...	0.0	0.0	pr.	pr.	0.0	0.0	0.0	pr.	0.0	0.0	0.0	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Diatomaceæ. 3. Schizomycetes, *Crenothrix*. 4. Protozoa.

Chemical Examination of Water from Gleason's Pond, Framingham.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
4315	1889. Mar. 14	Mar. 16	Slight.	Very slight.	0.1	2.35	0.65	1.70	.0000	.0174 .0138	.34	.0030	.0000

Odor, faintly mouldy.——The sample was collected from the pond at the ice-house wharf.

Microscopical Examination.

March, 1889. 1. Blue-green algæ, 0.0; 2. Other algæ, 0.2; 3. Fungi, 0.04; Animal forms, pr. Groups and principal genera of organisms observed: 2. Diatomaceæ. 4. Protozoa.

Chemical Examination of Water from Learned's Pond, Framingham.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
4316	1889. Mar. 14	Mar. 16	Slight.	Very slight.	0.05	1.35	0.60	0.75	.0000	.0154 .0114	.21	.0030	.0000

Odor, faintly earthy.——The sample was collected near the west shore of the pond.

Microscopical Examination.

March, 1889. 1. Blue-green algæ, 0.0; 2. Other algæ, pr; 3. Fungi, 0.0; 4. Animal forms, 0.5. Groups and principal genera of organisms observed: 2. Zoosporeæ. 4. Protozoa; Entomostraca.

Water Supply of Franklin. — Franklin Water Company.

Description of Works. — Population in 1885, 3,983. The works are owned by the Franklin Water Company, and were built in 1884. The average daily consumption in 1889 was 74,768 gallons. The sources of supply are two large wells located on the bank of Mine Brook. The first well, built in 1884, is 20 feet in diameter and about 25 feet deep; a direct connection made with Beaver Pond, which is a short distance from the well, was used in emergencies until 1887. The area of Beaver Pond is 30 acres; depth, 30 to 60 feet. About one-half the bottom of the pond is sandy and the remainder muddy. There is a small amount of shallow flowage. In 1887 a second well, 33 feet in diameter and 18 feet deep, was constructed near the first one, and since that time

the wells have furnished the entire supply of water for the town. Pumps force the water to an open iron tank 30 feet in diameter and 80 feet high. Distributing mains are of wrought iron lined with cement. Service pipes are of wrought iron, coated with tar.

Chemical Examination of Water from the Wells of the Franklin Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
141	June 20	June 21	Very slight.	None.	0.0	9.60	–	–	.0008	.0012	0.88	.3900	–
354	July 18	July 19	None.	None.	0.0	10.40	–	–	.0000	.0011	1.05	.2600	–
543	Aug. 15	Aug. 16	Slight, milky.	None.	0.0	10.10	–	–	.0004	.0017	0.85	.1630	–
544	Aug. 15	Aug. 16	Slight. milky.	Slight.	0.1	9.95	–	–	.0002	.0018	0.84	.1460	–
755	Sept. 13	Sept. 14	Very slight.	Slight, earthy.	0.0	9.25	–	–	.0000	.0013	0.94	.1950	–
963	Oct. 17	Oct. 18	Very slight.	Very slight.	0.0	8.70	–	–	.0000	.0010	0.90	.1950	–
1183	Nov. 14	Nov. 15	None.	None.	0.0	8.55	–	–	.0000	.0010	0.98	.2400	–
1426	Dec. 16	Dec. 17	None.	None.	0.0	8.75	–	–	.0000	.0022	1.01	.3000	–
	1888.												
1614	Jan. 17	Jan. 18	None.	Very slight.	0.0	8.40	–	–	.0000	.0010	0.87	.2500	.0005
1793	Feb. 10	Feb. 10	None.	None.	0.0	8.05	–	–	.0000	.0034	0.82	.2000	.0001
2072	Mar. 21	Mar. 22	Slight, milky.	Very slight.	0.0	7.70	–	–	.0000	.0010	0.81	.1600	.0000
2287	Apr. 23	Apr. 24	None.	None.	0.0	6.55	–	–	.0000	.0018	0.76	.2000	.0002
2490	May 22	May 23	Slight.	Very slight.	0.0	7.95	–	–	.0000	.0010	0.77	.2000	.0000
Av.	....	....	....	....	–	8.77	–	–	.0001	.0015	0.88	.2230	.0002

Hardness in May, 1888, 3.5. Odor, none.——Samples numbered 544, 1614, 1793, 2072 and 2490 were collected from a faucet in the village; the remaining samples were collected from a faucet at the pumping station while pumping. A new well was being dug close to the old one at time of collection of Nos. 543 and 544. It was completed and connected with the other just before the collection of No. 755.

Microscopical Examination.

	1888. March.	1888. April.	1888. May.
1. Blue-green Algæ, ...	0.0	0.0	0.0
2. Other Algæ, ...	pr.	pr.	0.0
3. Fungi, ...	0.0	0.0	0.0
4. Animal Forms, ...	pr.	0.0	0.0

Groups and principal genera of organisms observed: 2. Diatomaceæ. 4. Protozoa.

Chemical Examination of Water from Beaver Pond in Franklin.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1887.												
142	June 20	June 21	Slight.	None.	0.5	3.77	1.92	1.85	.0003	.0311	.30	.0130	–
353	July 18	July 19	Very slight.	Very slight.	0.7	3.85	1.50	2.35	.0004	.0265	.25	.0040	–

Odor, decidedly vegetable.——The samples were collected from a faucet at the pumping station while temporarily drawing water from the pond only.

Chemical Examination of Water from Mine Brook in Franklin.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1887.												
962	Oct. 17	Oct. 18	Slight.	Slight, brown.	0.45	5.20	1.05	4.15	.0052	.0153	.39	.0130	–

Odor, decidedly vegetable.——The sample was collected from Mine Brook near the wells of the Franklin Water Company.

Freetown.

Chemical Examination of Water from Forge Pond, Freetown.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1889.												
4298	Mar. 14	Mar. 14	Very slight.	None.	1.3	3.50	1.80	1.70	.0020	.0244 .0196	.32	.0040	.0001

Odor, very faintly vegetable. —— The sample was collected from the pond.

WATER SUPPLY OF GARDNER. — GARDNER WATER COMPANY.

Description of Works. — Population in 1885, 7,283. The works are owned by the Gardner Water Company. Water was introduced in 1882. The average daily consumption in 1888 was 308,743 gallons. The source of supply is Crystal Lake in Gardner. Area, 156 acres; maximum depth at least 40 feet; bottom, gravel and ledge. There is no shallow flowage. Its drainage area, including the area of the pond, as estimated from the new topographical map of Massachusetts, is 550 acres. The population on the drainage area is not large, although the village is beginning to encroach upon it. Pumps force the water to an open distributing reservoir, 400 feet long and 150 feet wide, with a capacity of 5,000,000 gallons. The depth of water, when full, is 20 feet. The bottom is of clay and the slopes are paved. Distributing mains are of cast iron and service pipes are of tar-coated wrought iron.

Chemical Examination of Water from Crystal Lake.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1887.												
193	June 24	June 25	None.	None.	0.00	3.10	0.55	2.55	.0000	.0102	.21	.0000	–
444	July 29	July 30	Slight.	None.	0.05	2.50	0.27	2.23	.0002	.0098	.17	.0000	–
632	Aug. 26	Aug. 27	Very slight.	Very slight.	0.05	2.47	0.60	1.87	.0017	.0133	.22	.0030	–
851	Sept. 23	Sept. 24	Very slight.	Very slight.	0.05	2.80	0.90	1.90	.0000	.0141	.14	.0000	–
1136	Nov. 9	Nov. 10	Very slight.	Very slight.	0.00	2.50	0.75	1.75	.0000	.0094	.23	.0050	–
1330	Dec. 6	Dec. 7	Very slight.	None.	0.00	2.55	0.65	1.90	.0006	.0102	.22	.0020	–
1479	Dec. 22	Dec. 23	None.	Very slight.	0.00	2.50	0.60	1.90	.0017	.0104	.27	.0030	–
	1888.												
1715	Jan. 31	Feb. 1	Very slight.	Very slight.	0.00	2.50	0.65	1.85	.0032	.0104	.18	.0100	.0001
1939	Mar. 1	Mar. 2	None.	None.	0.00	2.65	0.65	2.00	.0034	.0106	.28	.0100	.0001
2103	Mar. 26	Mar. 27	Slight.	Very slight.	0.00	2.65	0.35	2.30	.0026	.0116	.23	.0100	.0000
2309	Apr. 25	Apr. 26	Slight.	None.	0.00	2.60	0.75	1.85	.0008	.0088	.23	.0100	.0001
2518	May 25	May 28	Slight.	Very slight.	0.05	2.60	0.70	1.90	.0016	.0146	.19	.0070	.0002
Av.	....	....	....	....	–	2.62	0.62	2.00	.0013	.0111	.21	.0050	.0001

Hardness in May, 1888, 1.1. Odor, very faint or none. —— The samples were generally collected from a faucet at the pumping station while pumping. There were heavy rains just previous to the collection of Nos. 193 and 444. Water in the lake was very high at the time No. 632 was collected, being 28 inches higher than at the time of collecting No. 444.

Microscopical Examination.

	1888.		
	March.	April.	May.
1. Blue-green Algæ,	0.0	pr.	0.0
2. Other Algæ,	0.0	pr.	pr.
3. Fungi,	0.0	0.0	0.0
4. Animal Forms,	0.0	0.0	pr.

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Diatomaceæ. 4. Protozoa.

Chemical Examination of Water from the Distributing Reservoir of the Gardner Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Exam-ination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albu-minoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
192	June 24	June 25	Very slight.	Slight.	0.00	2.62	0.97	1.65	.0006	.0111	.24	.0000	–
443	July 27	July 30	Very slight.	Very slight.	0.05	2.82	0.55	2.27	.0003	.0124	.20	.0030	–
631	Aug. 26	Aug. 27	Decided, milky.	Slight.	0.05	2.85	0.70	2.15	.0006	.0160	.19	.0000	–
850	Sept. 23	Sept. 24	Distinct.	Slight.	0.05	2.60	0.55	2.05	.0000	.0153	.10	.0030	–
1137	Nov. 9	Nov. 10	Decided, milky.	Consid'ble, earthy.	0.05	3.70	0.90	2.80	.0002	.0156	.21	.0040	–
1331	Dec. 6	Dec. 7	Slight.	Slight.	0.00	2.65	0.55	2.10	.0072	.0104	.21	.0030	–
1478	Dec. 22	Dec. 23	Slight.	Slight.	0.10	2.55	0.60	1.95	.0004	.0114	.24	.0080	.0002
	1888.												
1714	Jan. 31	Feb. 1	Distinct.	Sli't, rusty.	0.05	2.85	0.70	2.15	.0000	.0108	.19	.0150	.0000
1940	Mar. 1	Mar. 2	Slight.	None.	0.00	2.85	0.60	2.25	.0034	.0100	.28	.0120	.0001
2090	Mar. 23	Mar. 24	Slight.	Very slight.	0.05	2.75	0.60	2.15	.0028	.0102	.27	.0100	.0002
2310	Apr. 25	Apr. 26	Distinct.	Slight.	0.00	2.85	1.00	1.85	.0000	.0127	.21	.0100	.0001
2517	May 25	May 28	Distinct.	Much, brown.	0.05	2.60	0.75	1.85	.0022	.0152	.19	.0090	.0001
Av.	....	....	....	....	0.04	2.81	0.71	2.10	.0015	.0126	.21	.0064	.0001

Hardness in May, 1888, 1.3. Odor, very faint or none.——The samples were collected from the reservoir. The sides of the reservoir were badly washed by rain a short time previous to the collection of No. 631.

Microscopical Examination.

	1888.		
	March.	April.	May.
1. Blue-green Algæ,	0.0	0.0	0.0
2. Other Algæ,	pr.	pr.	pr.
3. Fungi,	0.0	0.0	0.0
4. Animal Forms,	pr.	pr.	pr.

Groups and principal genera of organisms observed: 2. Palmellaceæ; Zoosporeæ; Diatomaceæ. 4. Protozoa.

Water Supply of Gill. — Riverside Water Company.

Description of Works. — Population of the town of Gill in 1885, 860. The works are owned by the Riverside Water Company, and supply 56 water takers in the village of Riverside. The source of supply is Heal-All Spring, from which water is supplied to the village by gravity through a main pipe three inches in diameter. It has been proposed to obtain an additional supply from Nevin's Brook.

Chemical Examination of Water from Nevin's Brook in Gill.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
4254	Mar. 7	Mar. 9	Very slight.	Consid'ble, earthy and flocculent.	0.1	4.10	0.40	3.70	.0000	.0096 .0064	.06	.0060	.0004

Hardness, 2.6. Odor, faintly earthy. —— The sample was collected from the brook when the water was high on account of rain and melting snow.

Microscopical Examination.

March, 1889. 1. Blue-green algæ, 0.0; 2. Other algæ, 0.4; 3. Fungi, pr. Groups and principal genera of organisms observed: 2. Diatomaceæ; Zygnemaceæ. 3. Schizomycetes.

Water Supply of Gloucester. — Gloucester Water Supply Company.

Description of Works. — Population in 1885, 21,703. The works are owned by the Gloucester Water Supply Company. Water was introduced in 1885. The average daily consumption in 1888 was 387,427 gallons. The sources of supply are two storage reservoirs situated in West Gloucester. The main reservoir, known as Dikes' Storage Reservoir, has an area of about 88 acres and an average depth of about 18 feet. Its watershed is 408 acres and its height above the sea 92 feet. It was formed by flowing an extensive meadow. The second storage reservoir, known as Wallace Pond, is located farther down the stream, at an elevation of 61 feet above the sea. Its watershed is 178 acres. Water has not yet been used from this reservoir. The watersheds of both reservoirs are uninhabited, and are sterile and rocky and contain but little swamp land. Water is brought through a pipe from Dikes' Reservoir to the pumping station, where it is forced to a distributing reservoir. All water

pumped passes through this reservoir. Distributing mains are of wrought iron lined with cement and of cast iron. Service pipes are of wrought iron coated with tar.

Chemical Examination of Water from Dikes' Brook Storage Reservoir.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1887.												
286	July 7	July 8	Slight.	Slight.	0.80	4.55	1.40	3.15	.0060	.0220	.69	.0000	–
509	Aug. 9	Aug. 9	Slight.	Slight.	1.10	5.75	1.85	3.90	.0116	.0209	.76	.0000	–
856	Sept. 27	Sept. 28	Slight.	Slight, rusty.	0.50	4.95	1.75	3.20	.0029	.0267	.76	.0030	–
1178	Nov. 12	Nov. 14	Slight.	Consid'ble.	0.70	4.72	1.92	2.80	.0323	.0309	.77	.0050	–
	1888.												
1754	Feb. 4	Feb. 6	Very slight.	Very slight.	0.70	4.95	1.95	3.00	.0028	.0273	.79	.0100	.0000
1956	Mar. 6	Mar. 7	Slight.	Consid'ble, green.	0.70	5.00	2.30	2.70	.0002	.0404	.81	.0050	.0000
2162	Apr. 6	Apr. 7	Very slight.	Slight.	0.60	3.70	1.30	2.40	.0002	.0249	.72	.0050	.0002
2364	May 7	May 8	Very slight.	Slight.	0.40	3.75	1.40	2.35	.0004	.0182	.70	.0050	.0001
2598	June 13	June 14	Very slight.	Slight, white.	0.50	3.95	1.10	2.85	.0018	.0190 .0162	.64	.0080	.0002
2749	July 10	July 10	Distinct.	None.	0.30	2.95	1.20	1.75	.0020	.0228 .0194	.73	.0020	.0001
2877	Aug. 2	Aug. 3	Slight.	Very slight.	0.40	4.20	1.25	2.95	.0154	.0212 .0144	.71	.0020	.0001
3110	Sept. 7	Sept. 8	Distinct.	Considerable.	0.30	4.55	1.60	2.95	.0230	.0284 .0172	.68	.0030	.0003
3308	Oct. 3	Oct. 4	Very slight.	Very slight.	0.20	4.00	1.15	2.85	.0174	.0194 .0174	.66	.0070	.0004
3515	Nov. 8	Nov. 9	Slight.	Very slight.	0.70	4.20	1.70	2.50	.0174	.0232 .0226	.73	.0070	.0002
3692	Dec. 10	Dec. 11	Very slight.	Very slight.	0.40	3.95	1.15	2.80	.0038	.0220 .0194	.77	.0100	.0003
	1889.												
3827	Jan. 7	Jan. 8	Very slight.	None.	0.50	3.90	1.55	2.35	.0002	.0188 .0172	.77	.0040	.0002
4004	Feb. 9	Feb. 11	Distinct.	Slight, yellow green.	0.40	3.85	1.45	2.40	.0006	.0226 .0166	.80	.0030	.0000
4244	Mar. 7	Mar. 8	Slight.	Slight.	0.50	3.55	1.10	2.45	.0000	.0152 .0110	.80	.0030	.0001
4473	Apr. 6	Apr. 6	Very slight.	None.	0.40	3.50	1.25	2.25	.0000	.0174 .0160	.74	.0030	.0002
4618	May 6	May 7	Very slight.	Very slight.	0.30	3.55	1.40	2.15	.0004	.0162 .0144	.73	.0030	.0002
Av.	....	....	....	....	0.52	4.67	1.73	2.94	.0069	.0229	.74	.0044	.0002

Hardness in May, 1888, 1.8. Odor, faintly vegetable, frequently mouldy.—— The samples were collected from a faucet at the pumping station. The reservoir was lower than usual on March 6, 1888. At the time of collecting Nos. 2162 and 3308 the water in the reservoir was very high on account of heavy rains.

Microscopical Examination.

	1888.							1889.				
	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ, ...	0.0	0.0	0.0	0.0	pr.	0.0	0.0	0.0	0.0	pr.	0.2	0.0
2. Other Algæ, ...	1.0	1.0	0.6	0.2	0.0	pr.	1.0	0.4	0.0	0.2	0.5	0.0
3. Fungi, ...	0.7	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, ...	0.0	pr.	pr.	0.0	pr.	pr.	0.0	0.0	1.8	2.0	0.5	pr.

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ, *Chlorococcus*, *Protococcus;* Zoosporeæ; Diatomaceæ. 3. Schizomycetes. 4. Protozoa, *Peridinium*.

Chemical Examination of Water from the Distributing Reservoir of the Gloucester Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Exam-ination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albu-minoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.	1887.											
285	July 7	July 8	Slight.	Slight.	0.80	5.05	1.47	3.58	.0048	.0200	.74	.0000	–
508	Aug. 9	Aug. 9	Decided.	Heavy, brown.	0.80	5.87	1.60	4.27	.0024	.0248	.78	.0000	–
1179	Nov. 12	Nov. 14	Slight.	Considerable.	0.70	4.75	1.77	2.98	.0347	.0326	.81	.0040	–
	1888.	1888.											
1753	Feb. 4	Feb. 6	Slight.	Very slight.	0.70	5.00	2.15	2.85	.0028	.0248	.79	.0100	.0000
1978	Mar. 7	Mar. 9	Slight.	Very slight.	0.65	5.45	2.15	3.30	.0021	.0312	.80	.0050	.0000
2172	Apr. 9	Apr. 10	Decided.	Slight.	0.60	4.00	1.45	2.55	.0000	.0287	.70	.0000	.0002
Av.	....	....	....	....	0.71	5.02	1.77	3.25	.0078	.0270	.77	.0032	–

Odor, faintly vegetable and mouldy. —— The samples were collected from the reservoir, with the exception of 1978 and 2172, which were collected from a faucet in the city.

Microscopical Examination.

April, 1888. 1. Blue-green algæ, 0.0; 2. Other algæ, pr. 3. Fungi, 0.0; 4. Animal forms, pr. Groups and principal genera of organisms observed: 2. Zoosporeæ; Diatomaceæ. 4. Protozoa.

Chemical Examination of Water from Day's Upper Pond, Gloucester.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Exam-ination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albu-minoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.	1888.											
3387	Oct. 17	Oct. 18	Slight.	Very slight.	0.1	5.35	1.30	4.05	.0032	.0196 .0142	1.13	.0500	.0005

Odor, distinctly mouldy. —— The sample was collected from the pond near the ice-house.

Chemical Examination of Water from Day's Lower Pond, Gloucester.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.		Nitrates.	Nitrites.
	1889.												
4261	Mar. 8	Mar. 9	Decided.	Consid'ble.	0.2	6.30	1.80	4.50	.0000	.0366 .0210	1.63	.0180	.0008

Odor, very faintly mouldy.——The sample was collected from the pond near the shore.

Chemical Examination of Water from Webster's Pond, Gloucester.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.		Nitrates.	Nitrites.
	1889.												
4260	Mar. 8	Mar. 9	Very slight.	Very slight.	0.15	6.05	1.50	4.55	.0004	.0132 .0092	1.34	.1000	.0003

Odor, none.——The sample was collected from the pond near the dam.

Water Supply of Grafton. — Grafton Water Company.

Description of Works. — Population in 1885, 4,498. The works are owned by the Grafton Water Company, and were built in 1886. The average daily consumption in 1888 was about 100,000 gallons. The source of supply, until early in 1889, was a covered gallery, which collects water from several large springs. Since this time the supply has been increased by sinking tubular wells. The gallery is 95 feet long, 12 feet wide and 17 feet high; its bottom is 20 feet below the surface of the ground. Pumps force the water to an open iron tank 25 feet in diameter and 30 feet high. Distributing mains are of cast iron and service pipes of enameled iron.

Chemical Examination of Water from the Gallery of the Grafton Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
140	June 20	June 20	Very slight.	None.	0.00	11.50	–	–	.0000	.0013	1.47	.1300	–
363	July 19	July 20	None.	None.	0.00	10.80	–	–	.0000	.0022	1.38	.1110	–
560	Aug. 16	Aug. 17	None.	None.	0.00	10.70	–	–	.0004	.0017	1.30	.2270	–
765	Sept. 14	Sept. 15	Distinct.	Very slight.	0.00	10.30	–	–	.0000	.0038	1.38	.2600	–
947	Oct. 13	Oct. 14	Distinct.	Slight, earthy.	0.00	9.75	–	–	.0000	.0028	1.31	.2500	–
1162	Nov. 11	Nov. 12	None.	None.	0.00	9.05	–	–	.0000	.0014	1.24	.2500	–
	1888.												
1613	Jan. 17	Jan. 18	None.	None.	0.00	10.95	–	–	.0003	.0022	1.70	.3250	.0003
1806	Feb. 13	Feb. 14	None.	None.	0.00	10.20	–	–	.0000	.0016	1.57	.4000	.0002
2051	Mar. 19	Mar. 20	None.	None.	0.00	10.30	–	–	.0008	.0035	1.49	.2500	.0001
2223	Apr. 16	Apr. 17	None.	None.	0.00	11.30	–	–	.0000	.0020	1.68	.3200	.0001
2472	May 21	May 22	None.	Slight, white.	0.00	13.55	–	–	.0002	.0030	2.12	.3200	.0000
Av.	....	....	....	....	0.00	10.76	–	–	.0002	.0023	1.51	.2585	.0001

Hardness in May, 1888, 5.3. Odor, very faint or none.——The samples were collected from a faucet in the village, excepting Nos. 140 and 363, which were collected from the gallery.

Microscopical Examination.

	1888. March.	1888. April.	1888. May.
1. Blue-green Algæ, ...	0.0	0.0	0.0
2. Other Algæ, ...	0.0	pr.	pr.
3. Fungi, ...	0.0	0.0	0.0
4. Animal Forms, ...	0.0	0.0	0.0

Groups and principal genera of organisms observed: 2. Diatomaceæ.

Water Supply of Great Barrington. — Great Barrington Water Company.

Description of Works. — Population in 1885, 4,471. The works are owned by the Great Barrington Water Company. Water was introduced in 1867. The source of supply is a small mountain brook, on which a very small storage reservoir is built. The area of the reservoir is estimated to be about one acre. Maximum depth,

12 feet; average depth, about 6 feet; bottom, clay; capacity, about 1,700,000 gallons. The natural drainage area, estimated from the new topographical map of Massachusetts, is about 134 acres. The slopes are very steep and heavily wooded. There is very little cleared land and no population on the drainage area. In the vicinity of the reservoir there is a dense growth of evergreen trees extending to the water's edge. Water is distributed by gravity. Distributing mains are of cast iron and service pipes of wrought iron.

In addition to the Great Barrington Water Company, there are three other water companies in this town. The Mansfield Lake Aqueduct Company furnishes water from Mansfield Lake to a very few persons, and at times supplies water to the Great Barrington Water Company. The Berkshire Heights Water Company constructed works in 1887 for pumping water from Green River in Great Barrington to a distributing reservoir to supply a portion of the town. These works are not yet in operation. The Housatonic Water Company was chartered to supply the village of Housatonic, which is in the northern part of Great Barrington very near the line between Great Barrington and Stockbridge. Water was introduced in December, 1888. The source of supply is Long Lake in Great Barrington. Water is distributed by gravity. Distributing mains are of cast iron; service pipes are of galvanized iron.

Chemical Examination of Water from the Storage Reservoir of the Great Barrington Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
690	Sept. 5	Sept. 6	Very slight.	Slight.	0.05	3.87	0.07	3.80	.0000	.0048	.08	.0100	–
906	Oct. 7	Oct. 10	Very slight.	None.	0.05	5.10	0.50	4.60	.0012	.0054	.08	.0030	–
908	Oct. 7	Oct. 10	None.	Very slight.	0.05	5.00	0.70	4.30	.0000	.0022	.08	.0070	–
1348	Dec. 6	Dec. 8	Very slight.	Slight, earthy.	0.00	4.95	0.50	4.45	.0010	.0077	.15	.0180	–
1349	Dec. 6	Dec. 8	None.	None.	0.05	5.40	1.05	4.35	.0000	.0052	.17	.0180	–
	1888.												
1535	Jan. 4	Jan. 5	None.	Slight.	0.10	3.80	0.80	3.00	.0000	.0069	.13	.0120	.0000
2418	May 14	May 15	Very slight.	Very slight.	0.10	3.95	0.50	3.45	.0000	.0050	.08	.0020	.0000
Av.	....	....	....	....	0.06	4.70	0.67	4.03	.0003	.0053	.11	.0100	–

Hardness in May, 1888, 2.8. Odor, none or faintly mouldy.—— The samples were collected from a faucet in the village excepting Nos. 906 and 1348, which were collected from the reservoir, and No. 908, which was collected from the brook where it enters the reservoir.

Microscopical Examination.

May, 1888. 1. Blue-green algæ, 0.0; 2. Other algæ, pr.; 3. Fungi, 0.0; 4. Animal forms, pr.
Groups and principal genera of organisms observed: 2. Diatomaceæ. 4. Protozoa.

Chemical Examination of Water from Mansfield Lake, Great Barrington.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
909	Oct. 7	Oct. 10	Slight.	Sli't, white.	0.10	12.65	1.80	10.85	.0009	.0281	.10	.0030	–
1347	Dec. 6	Dec. 8	Slight.	Consid'ble, earthy.	0.05	9.15	1.55	7.60	.0060	.0186	.10	.0150	–

Odor, very faintly vegetable.——The samples were collected from the lake.

Chemical Examination of Water from Green River in Great Barrington.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
336	July 13	July 14	Very slight.	Slight.	0.0	8.07	0.70	7.37	.0006	.0059	.10	.0130	–
907	Oct. 7	Oct. 10	Very slight.	Slight.	0.0	10.10	0.80	9.30	.0000	.0028	.08	.0260	–
1346	Dec. 6	Dec. 8	Very slight.	Slight.	0.0	8.15	1.00	7.15	.0012	.0083	.13	.0200	–
Av.	....	....	....	....	0.0	8.77	0.83	7.94	.0006	.0057	.10	.0197	–

Odor, none or faintly mouldy.——The samples were collected from the river. The river was somewhat swollen by rains just previous to the collection of Nos. 336 and 1346.

Water Supply of Greenfield Fire District, Greenfield.

Description of Works. — Population in 1885, 4,869. The works are owned by the Greenfield Fire District. Water was introduced in 1870. The average daily consumption in 1888 is estimated to have been about 400,000 gallons. The source of supply is Glen Brook in Leyden, on which a storage reservoir is built. The area of the reservoir is 5¼ acres and its capacity 18,000,000 gallons. Its maximum depth is 32 feet, and there is about one acre of shallow flowage. The drainage area of about 5.36 square miles, estimated

from the new topographical map of Massachusetts, is mountainous, and contains but a very small population. Water is distributed by gravity. The original distributing mains were very small, and were replaced in 1885 with larger ones of cast iron. The service pipes are of galvanized iron.

Chemical Examination of Water from Glen Brook Storage Reservoir.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
74	June 9	June 11	-	-	0.00	5.40	0.75	4.65	.0071	.0046	.15	.0130	-
274	July 7	July 8	Very slight.	None.	0.00	5.05	0.60	4.45	.0004	.0057	.15	.0030	-
517	Aug. 10	Aug. 11	None.	Very slight.	0.05	5.75	0.42	5.33	.0002	.0054	.16	.0070	-
705	Sept. 7	Sept. 8	Distinct.	Very slight.	0.00	5.40	0.22	5.18	.0003	.0041	.12	.0070	-
899	Oct. 6	Oct. 7	Very slight.	Sli't, earthy.	0.10	6.05	0.45	5.60	.0000	.0073	.09	.0070	-
1115	Nov. 7	Nov. 8	None.	None.	0.00	5.90	0.70	5.20	.0000	.0054	.14	.0020	-
1343	Dec. 7	Dec. 8	Very slight.	None.	0.10	5.60	0.65	4.95	.0002	.0042	.13	.0050	-
	1888.												
1747	Feb. 3	Feb. 4	None.	None.	0.00	5.10	0.45	4.65	.0000	.0012	.13	.0120	.0000
2158	Apr. 3	Apr. 4	Sli't, milky.	None.	0.00	3.40	0.40	3.00	.0014	.0048	.07	.0150	.0000
2438	May 16	May 17	Slight.	Very slight.	0.00	4.00	0.40	3.60	.0000	.0038	.05	.0100	.0001
2800	July 18	July 19	Very slight.	Sli't, rusty.	0.05	5.65	0.50	5.15	.0018	.0062	.07	.0120	.0004
3710	Dec. 13	Dec. 14	None.	Very slight.	0.00	4.35	0.25	4.10	.0002	.0028	.09	.0150	.0000
Av.	....	....	....	....	0.03	5.09	0.48	4.61	.0010	.0046	.11	.0090	.0001

Hardness in May, 1888, 2.6. Odor, generally none, seldom vegetable or grassy.——The samples were collected from a faucet in the village.

Microscopical Examination.

	1888. April.	1888. May.	1888. July.	1888. Dec.
1. Blue-green Algæ,	0.0	0.0	0.0	0.0
2. Other Algæ,	pr.	0.0	0.1	0.2
3. Fungi,	0.0	0.0	pr.	0.0
4. Animal Forms,	0.0	0.0	0.2	0.0

Groups and principal genera of organisms observed. 2. Diatomaceæ; Desmidiaceæ. 3. Schizomycetes. 4. Protozoa.

Water Supply of Haverhill. — Haverhill Aqueduct Company.

Description of Works. — Population in 1885, 21,795. The works are owned by the Haverhill Aqueduct Company. Water was introduced in 1802. The sources of supply are four natural ponds, known as Lake Pentucket (Round Pond), Lake Saltonstall (Plug Pond), Kenoza Lake and Crystal Lake. Water was introduced from Lake Pentucket in 1802, and Saltonstall, Kenoza and Crystal lakes were added in the order named, Crystal Lake having been added since 1883. The areas of the ponds and of their watersheds, inclusive of water surfaces, are given below. The areas of the watersheds have been computed from the new topographical map of Massachusetts.

NAME.	Area of Watershed in Acres.	Area of Pond in Acres.
Lake Pentucket,	273	40
Lake Saltonstall,	221	38
Kenoza Lake,	794	232
Crystal Lake,	1,919	152
Total,	3,207	462

The watersheds are generally hilly and wooded. The population on the borders of the city is beginning to encroach upon a portion of the watershed of Lake Saltonstall; with this exception the watersheds contain very few inhabitants. From Kenoza Lake pumps force the water to an open iron tank 30 feet in diameter and 50 feet in height. Water is supplied from the other lakes by gravity. Water was at first supplied through wooden logs. Iron pipes were introduced about 1845. At present the distributing mains are of cast iron except in a few outlying districts, where they are of cement-lined wrought iron. Service pipes are of lead with the exception of a few, which are of wrought iron.

Chemical Examination of Water from Crystal Lake, Haverhill.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
120	June 15	June 17	Distinct.	Consid'ble, brown.	0.20	3.73	1.50	2.23	.0022	.0169	.24	.0000	–
340	July 15	July 16	Very slight.	None.	0.30	3.25	1.10	2.15	.0002	.0185	.20	.0070	–
597	Aug. 22	Aug. 23	None.	None.	0.10	3.22	0.70	2.52	.0008	.0177	.19	.0030	–
802	Sept. 16	Sept. 17	None.	Very slight.	0.05	3.25	0.90	2.35	.0003	.0178	.27	.0030	–
1024	Oct. 24	Oct. 25	Very slight.	Very slight.	0.25	3.15	0.85	2.30	.0005	.0168	.23	.0000	–
1225	Nov. 18	Nov. 19	Slight.	Very slight.	0.05	3.20	0.80	2.40	.0026	.0197	.23	.0000	–
	1888.												
1634	Jan. 19	Jan. 20	Very slight.	None.	0.10	3.30	1.15	2.15	.0008	.0146	.21	.0080	–
2035	Mar. 16	Mar. 17	Very slight.	Very slight.	0.10	3.20	0.80	2.40	.0008	.0120	.25	.0050	.0001
2461	May 18	May 19	Distinct.	Very slight.	0.05	2.70	1.00	1.70	.0000	.0150	.21	.0030	.0003
Av.	....	....	....	....	0.13	3.22	0.98	2.24	.0009	.0166	.23	.0030	–

Hardness in May, 1888, 1.5. Odor, very faintly vegetable. —— The samples were collected from a faucet in the city supplied from Crystal Lake. At the time of collecting No. 2461 the water in the lake was very high.

Microscopical Examination.

March, 1888. 1. Blue-green algæ, 0.0; 2. Other algæ, pr.; 3. Fungi, 0.0; 4. Animal forms, 0.0. May, 1888. 1. Blue-green algæ, pr.; 2. Other algæ, pr.; 3. Fungi, 0.0; 4. Animal forms, pr.

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Desmidiaceæ; Diatomaceæ. 4. Protozoa.

Chemical Examination of Water from Kenoza Lake, Haverhill.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
119	June 15	June 17	Slight.	Very slight.	0.00	3.95	0.97	2.98	.0006	.0139	.39	.0000	
339	July 15	July 16	Very slight.	None.	0.00	4.20	1.05	3.15	.0008	.0178	.36	.0000	–
596	Aug. 22	Aug. 23	Slight.	None.	0.05	3.63	0.45	3.18	.0004	.0131	.30	.0030	–
805	Sept. 16	Sept. 17	Very slight.	Very slight.	0.00	3.60	0.40	3.15	.0014	.0111	.33	.0050	–
1025	Oct. 24	Oct. 25	Distinct.	Very slight, white.	0.10	3.60	0.65	2.95	.0002	.0138	.30	.0000	–
1226	Nov. 18	Nov. 19	Very slight.	Slight.	0.00	3.95	0.75	3.20	.0021	.0176	.34	.0020	–

Chemical Examination of Water from Kenoza Lake, Haverhill — Concluded.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
1635	Jan. 19	Jan. 20	None.	Slight.	0.00	3.40	0.60	2.80	.0007	.0114	.30	.0060	–
2033	Mar. 16	Mar. 17	Very slight.	None.	0.00	4.25	0.95	3.30	.0006	.0142	.37	.0080	.0001
2462	May 18	May 19	Very slight.	None.	0.00	3.70	0.80	2.90	.0000	.0138	.35	.0180	.0000
2660	June 25	June 26	–	–	0.00	2.10	0.60	1.50	.0000	.0148 .0144	.34	.0050	.0000
2882	Aug. 2	Aug. 3	Very slight.	Very slight.	0.05	3.75	1.05	2.70	.0008	.0186 .0176	.36	.0000	.0001
3277	Sept. 26	Sept. 28	Slight.	Very slight.	0.00	3.45	0.80	2.65	.0002	.0162 .0148	.33	.0030	.0000
3413	Oct. 19	Oct. 20	Very slight.	Slight.	0.00	3.50	0.85	2.65	.0000	.0140 .0116	.33	.0060	.0000
3570	Nov. 16	Nov. 17	Very slight.	Slight, white.	0.00	3.50	0.75	2.75	.0000	.0152 .0128	.30	.0050	.0000
3714	Dec. 14	Dec. 14	Slight.	Very slight.	0.03	3.60	0.85	2.75	.0006	.0146 .0128	.34	.0030	.0000
	1889.												
3879	Jan. 18	Jan. 19	Decided, milky.	Slight, white.	0.00	3.50	0.80	2.70	.0000	.0144 .0124	.33	.0070	.0001
4097	Feb. 22	Feb. 23	Slight.	None.	0.05	3.70	0.90	2.80	.0002	.0118 .0114	.34	.0070	.0004
4378	Mar. 22	Mar. 23	None.	None.	0.10	3.45	0.85	2.60	.0008	.0116 .0106	.35	.0050	.0000
4547	Apr. 19	Apr. 20	Very slight.	Very slight	0.05	3.70	1.00	2.70	.0004	.0118 –	.33	.0030	.0000
4803	June 7	June 8	Very slight.	Very slight.	0.00	3.65	0.95	2.70	.0014	.0150 .0132	.34	.0040	.0001
Av.	....	....	....	....	0.02	3.81	0.74	3.07	.0006	.0142	.34	.0045	.0001

Hardness in May, 1888, 1.9. Odor, generally none, seldom vegetable.——The samples were collected from a faucet in the pumping station while pumping, with the exception of No. 2882, which was collected from the lake. Heavy rains occurred just previous to the collection of Nos. 596, 2462 and 3277.

Microscopical Examination.

	1888. June.	1888. Aug.	1888. Sept.	1888. Oct.	1888. Nov.	1888. Dec.	1889. Jan.	1889. Feb.	1889. Mar.	1889. Apr.
1. Blue-green Algæ,	–	pr.	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ,	–	7.0	0.1	3.4	6.8	17.3	80.5	1.0	2.0	2.2
3. Fungi,	–	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms,	–	0.1	pr.	pr.	0.0	pr.	0.0	pr.	pr.	pr.

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Desmidiaceæ; Diatomaceæ, *Asterionella*, *Stephanodiscus*, *Tabellaria*. 4. Protozoa; Rotifera; Entomostraca.

Chemical Examination of Water from Lake Pentucket, Haverhill.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
122	June 15	June 17	Very slight.	Slight.	0.05	3.15	0.50	2.65	.0010	.0139	.41	.0000	–
342	July 15	July 16	Slight.	Very slight.	0.10	3.57	0.97	2.60	.0008	.0184	.39	.0030	–
599	Aug. 22	Aug. 23	Distinct.	Consid'ble.	0.05	3.72	0.65	3.07	.0002	.0158	.33	.0070	–
803	Sept. 16	Sept. 27	None.	Very slight.	0.00	3.50	0.80	2.72	.0003	.0171	.36	.0000	–
1026	Oct. 24	Oct. 25	Very slight.	Very slight.	0.00	3.30	0.50	2.80	.0000	.0174	.37	.0020	–
1228	Nov. 18	Nov. 19	Very slight.	Slight.	0.00	3.40	0.60	2.80	.0014	.0208	.39	.0020	–
	1888.												
1637	Jan. 19	Jan. 20	Very slight.	Very slight.	0.00	3.60	1.00	2.60	.0002	.0111	.38	.0100	–
2034	Mar. 16	Mar. 17	None.	None.	0.00	3.45	1.05	2.40	.0022	.0158	.41	.0070	.0001
2463	May 18	May 19	Slight.	Very slight.	0.00	3.05	0.95	2.10	.0000	.0174	.37	.0050	.0001
Av.	....	....	....	....	0.02	3.42	0.78	2.64	.0007	.0164	.38	.0040	–

Hardness in May, 1888, 1.4. Odor, very faintly vegetable, occasionally none. —— The samples were collected from a faucet in the city supplied from Lake Pentucket. Water in the lake was very high, at the time of collecting No. 599, on account of a heavy rain.

Microscopical Examination.

March, 1888. 1. Blue-green algæ, pr.; 2. Other algæ, 0.0; 3. Fungi, 0.0; 4. Animal forms, 0.0.
May, 1888. 1. Blue-green algæ, 0.0; 2. Other algæ, 0.0; 3. Fungi, 0.0; 4. Animal forms, pr.
Groups and principal genera of organisms observed: 1. Cyanophyceæ. 4. Protozoa.

Chemical Examination of Water from Lake Saltonstall, Haverhill.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
121	June 15	June 17	Very slight.	Slight.	0.00	4.92	0.92	4.00	.0016	.0123	.57	.0000	–
341	July 15	July 16	Slight.	None.	0.10	4.50	1.25	3.25	.0001	.0179	.53	.0030	–
598	Aug. 22	Aug. 23	Slight.	None.	0.10	3.40	0.62	2.78	.0004	.0161	.27	.0070	–
804	Sept. 16	Sept. 17	Very slight.	Very slight.	0.00	4.50	0.50	4.00	.0004	.0125	.61	.0000	–
1027	Oct. 24	Oct. 25	Slight.	Slight.	0.10	4.40	0.45	3.95	.0004	.0144	.59	.0000	–
1227	Nov. 18	Nov. 19	Very slight, milky.	Slight.	0.00	4.70	0.75	3.95	.0032	.0197	.62	.0040	–

Chemical Examination of Water from Lake Saltonstall, Haverhill — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.	1888.											
1636	Jan. 19	Jan. 20	Very slight.	None.	0.05	5.20	0.90	4.30	.0014	.0103	.59	.0100	–
2032	Mar. 16	Mar. 17	Very slight.	None.	0.05	4.70	0.80	3.90	.0052	.0134	.62	.0090	.0003
2464	May 18	May 19	Slight.	Very slight.	0.10	4.25	0.75	3.50	.0012	.0138	.59	.0090	.0003
Av.	....	....	....	....	0.05	4.51	0.77	3.74	.0015	.0145	.59	.0050	–

Hardness in May, 1888, 1.8. Odor, very faint or none, occasionally vegetable. —— The samples were collected from a faucet in the city supplied with water from Lake Saltonstall. At the time of collecting No. 598 the water in the lake was very high, on account of heavy rains.

Microscopical Examination.

March, May, 1888. 1. Blue-green algæ, 0.0; 2. Other algæ, pr.; 3. Fungi, 0.0; 4. Animal forms, pr.

Groups and principal genera of organisms observed: 2. Desmidiaceæ; Diatomaceæ. 4. Protozoa; Rotifera.

Water Supply of Hingham and Hull. — Hingham Water Company.

Description of Works. — Population in 1885, Hingham, 4,375; Hull, 451; total, 4,826. There is in addition a very large summer population. The works are owned by the Hingham Water Company. Water was introduced into Hingham in 1880 and into Hull in 1882. The average daily consumption in 1888 was estimated to be about 500,000 gallons. The sources of supply are Accord Pond and Fulling Mill Pond. Accord Pond is a natural pond 133 feet above mean high tide, having an area of 98 acres; average depth, 20 feet; maximum depth, 45 feet. Its bottom is gravelly, with muddy deposits in the deeper parts. There are about 4 or 5 acres of shallow flowage in a part of the pond distant from the outlet. Its drainage area of 366 acres is generally level and well wooded; it has some gravel hills of slight elevation. A small portion, estimated to be about 15 acres, is swamp land. Water is drawn from Accord Pond 80 feet from the shore and is distributed by gravity to Hingham. Fulling Mill Pond is a small storage reservoir and was first used as a source of water supply in 1886. Its area is about 14 acres and its average depth about 6 feet. It has a muddy bottom and there is

a small area of shallow flowage. Its superficial drainage area is small, but water probably enters the pond from beyond the gravel ridges which surround it. It is 30 feet above mean high tide. A crib 30 feet square is built in the pond and filled with stones and gravel. The sides are water-tight up to within 4 feet of high water. From the centre of this crib and 6 feet below high water a pipe leads to a basin 120 feet long, 50 feet wide and 10 feet deep, built of brick and stone laid in cement. From this basin pumps force the water to a covered tank 40 feet in diameter and 42 feet high. Fulling Mill Pond is used mainly to supply Hull, but water from Accord Pond can be drawn into the basin and used for the same purpose. Fulling Mill Pond is not used in winter and is generally drawn off in the fall and the bottom is cleaned. Distributing mains are of wrought iron lined with cement. Service pipes are of wrought iron lined with cement and of galvanized iron.

The water in Accord Pond has occasionally a bad taste and odor in the early summer, usually between June 1 and 20. It was found in one case that the water from near the surface caused no complaint, while the water drawn from several feet beneath the surface was objectionable.

Chemical Examination of Water from Accord Pond, Hingham.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1887.												
30	June 2	June 3	Slight.	None.	0.30	3.42	1.52	1.90	.0026	.0125	.49	.0000	–
266	July 6	July 7	Very slight.	Consid'ble, brown.	0.20	3.40	0.95	2.45	.0002	.0135	.55	.0070	–
476	Aug. 3	Aug. 5	Very slight.	None.	0.30	3.15	1.22	1.93	.0000	.0136	.48	.0030	–
694	Sept. 5	Sept. 7	Very slight.	None.	0.15	2.95	0.72	2.23	.0003	.0145	.55	.0100	–
877	Oct. 3	Oct. 4	None.	None.	0.10	2.95	0.75	2.20	.0002	.0112	.58	.0030	–
1108	Nov. 4	Nov. 5	Very slight.	Slight.	0.20	4.60	1.00	3.60	.0004	.0120	.59	.0070	–
1337	Dec. 6	Dec. 7	Very slight.	Very slight.	0.10	3.20	1.05	2.15	.0000	.0156	.58	.0000	–
	1888.												
1552	Jan. 6	Jan. 7	Slight.	None.	0.30	3.25	0.95	2.30	.0000	.0136	.63	.0050	.0000
1957	Mar. 6	Mar. 7	Very slight.	Very slight.	0.10	3.05	0.80	2.25	.0000	.0153	.56	.0050	.0000
2211	Apr. 13	Apr. 14	Very slight.	Slight.	0.30	3.00	1.00	2.00	.0004	.0189	.55	.0030	.0002
2361	May 4	May 5	Slight.	Very slight.	0.20	2.80	1.05	1.75	.0000	.0148	.56	.0020	.0001

Chemical Examination of Water from Accord Pond — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
2650	June 21	June 22	Very slight.	Slight.	0.25	2.60	1.05	1.55	.0000	.0142 .0122	.53	.0020	.0001
2748	July 9	July 10	Very slight.	Very slight.	0.20	2.95	1.05	1.90	.0004	.0174 .0158	.58	.0030	.0000
2915	Aug. 10	Aug. 13	Slight.	Slight.	0.10	2.90	0.85	2.05	.0000	.0162 .0158	.59	.0050	.0000
3342	Oct. 9	Oct. 11	Very slight.	Very slight.	0.15	2.95	1.10	1.85	.0000	.0156 .0134	.56	.0060	.0001
3531	Nov. 12	Nov. 13	Very slight.	Very slight.	0.30	2.80	1.05	1.75	.0000	.0174 .0168	.52	.0080	.0002
3778	Dec. 20	Dec. 21	Very slight.	Very slight.	0.30	3.05	0.85	2.20	.0006	.0186 .0144	.55	.0070	.0001
	1889.												
3846	Jan. 15	Jan. 15	Very slight.	Very slight.	0.40	3.15	1.00	2.15	.0000	.0124 .0116	.57	.0030	.0004
4009	Feb. 12	Feb. 12	Very slight.	Very slight.	0.40	3.25	1.25	2.00	.0000	.0140 .0122	.59	.0030	.0002
4277	Mar. 12	Mar. 12	Very slight.	None.	0.30	2.95	0.85	2.10	.0002	.0116 .0090	.53	.0050	.0002
4477	Apr. 9	Apr. 9	Very slight.	Slight.	0.30	3.05	1.00	2.05	.0004	.0116 .0106	.51	.0040	.0003
4636	May 10	May 10	Very slight.	Slight.	0.30	3.25	0.95	2.30	.0002	.0130 .0114	.52	.0040	.0002
Av.	....	....	....	....	0.24	3.25	1.00	2.25	.0003	.0144	.55	.0043	.0001

Hardness in May, 1888, 0.9. Odor, very faintly vegetable or grassy, seldom disagreeable. —— The samples were collected from the pond near the gate-house, with the exception of Nos. 1108, 3846, 4009, 4277, 4477 and 4636, which were collected from a faucet in the village. The samples collected at the pond were taken from depths varying from 6 inches to 6 feet beneath the surface. The surface of Accord Pond was 0.38 feet below the crest of the wasteway in June, 1887. From this time it lowered gradually until December, 1887, when it was 2.70 feet below the crest. In April, 1888, and again in December, 1888, the pond was full; while between these dates, in August, its surface was 2.44 feet below the crest. From January to May, 1889, the surface was at or near the level of the crest.

Microscopical Examination.

	1888. June.	1888. July.	1888. Aug.	1888. Oct.	1888. Nov.	1888. Dec.	1889. Jan.	1889. Feb.	1889. Mar.	1889. Apr.	1889. May.
1. Blue-green Algæ, ...	0.0	0.0	pr.	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	0.3	0.9	0.4	pr.	0.0	pr.	0.1	0.2	18.0	3.9	0.2
3. Fungi, ...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, ...	30.1	6.0	0.5	0.0	0.0	pr.	pr.	0.0	0.0	0.9	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Asterionella*. 4. Protozoa, *Dinobryon;* Spongiaria; Rotifera; Entomostraca.

Chemical Examination of Water from Fulling Mill Pond, Hingham.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
31	June 2	June 3	Very slight.	None.	0.70	5.70	2.52	3.18	.0036	.0158	.59	.0000	–
265	July 6	July 7	Decided.	Slight, rusty.	0.40	5.80	1.25	4.55	.0024	.0281	.72	.0030	–
475	Aug. 3	Aug. 5	Slight.	None.	0.50	5.55	1.18	4.37	.0031	.0240	.57	.0030	–
695	Sept. 5	Sept. 7	Very slight.	Slight, earthy.	0.15	4.80	0.65	4.15	.0077	.0178	.72	.0130	–
878	Oct. 3	Oct. 4	Distinct.	Sli't, earthy and floc't.	0.08	4.65	0.75	3.90	.0127	.0174	.75	.0160	–
	1888.												
2390	May 9	May 10	Decided.	Slight, green.	0.35	5.45	1.45	4.00	.0000	.0376	.68	.0030	.0002
2651	June 21	June 22	Distinct.	Considerable, white.	0.40	5.15	1.45	3.70	.0002	.0422 .0280	.67	.0020	.0002
2747	July 9	July 10	Decided.	Heavy, green.	0.20	5.20	1.75	3.45	.0004	.0470 .0286	.71	.0030	.0000
2916	Aug. 10	Aug. 13	Decided.	Considerable, green.	0.15	5.30	1.15	4.15	.0000	.0406 .0178	.72	.0020	.0001
3341	Oct. 9	Oct. 11	Decided.	Considerable, green.	0.45	5.20	1.60	3.60	.0002	.0336 .0148	.64	.0070	.0002
3530	Nov. 12	Nov. 13	Slight.	Slight.	0.40	5.20	1.60	3.60	.0030	.0200 .0164	.63	.0120	.0002
3779	Dec. 20	Dec. 21	Very slight.	Very slight.	0.50	4.85	1.30	3.55	.0000	.0148 .0142	.73	.0180	.0002
Av.	....	....	....	....	0.36	5.33	1.30	4.03	.0028	.0282	.68	.0068	.0002

Hardness in June, 1887, 2.1; in May, 1888, 1.8. Odor, faintly vegetable, grassy, and mouldy.—— The samples were collected from Fulling Mill Pond, at depths varying from a few inches to two feet beneath the surface.

Microscopical Examination.

	1888. June.	1888. July.	1888. Aug.	1888. Oct.	1888. Nov.	1888. Dec.
1. Blue-green Algæ,	0.0	0.0	0.0	–	0.0	0.0
2. Other Algæ,	59.2	51.3	335.3	–	0.1	0.9
3. Fungi,	0.0	0.0	0.0	–	0.0	0.0
4. Animal Forms,	pr.	pr.	0.2	–	pr.	0.4

Groups and principal genera of organisms observed: 2. Palmellaceæ; Zoosporeæ, *Polyedrium, Scenedesmus;* Desmidiaceæ, *Staurastrum;* Diatomaceæ, *Synedra;* Volvocineæ. 4. Protozoa, Rotifera, Entomostraca.

Water Supply of Hinsdale Fire District, Hinsdale.

Description of Works. — The population of the town of Hinsdale in 1885 was 1656. The works are owned by the Fire District and were constructed in 1889. About 200 families are supplied. The source of supply is a storage reservoir on a small mountain stream. The area of the storage reservoir is about 9 acres and its total capacity is 35,000,000 gallons. Its maximum depth is 21 feet. The bottom is turf and loam overlying rock and hard pan. Water is distributed by gravity. Distributing mains are of cast iron; service pipes are of galvanized iron.

Chemical Examination of Water from the Proposed Water Supply of Hinsdale.

[Parts per 100,000.]

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.
	1889.												
3982	Feb. 5	Feb. 7	None.	Slight.	0.00	1.70	0.45	1.25	.0006	.0046 .0040	.05	.0100	.0000

Hardness, 0.5. Odor, none. —— The sample was collected from a brook one mile west of Hinsdale village. The storage reservoir of the Hinsdale Fire District has been built upon this brook.

Microscopical Examination.

February, 1889. 1. Blue-green algæ, 0.0; 2. Other algæ, 0.7; 3. Fungi, 0.0; 4. Animal forms, 0.0. Groups and principal genera of organisms observed: 2. Diatomaceæ.

Water Supply of Holbrook.

This town is supplied jointly with Randolph. *See Randolph.*

Water Supply of Holyoke.

Description of Works. — Population in 1885, 27,895. The works are owned by the city. Water was introduced in 1873. The estimated average daily consumption in 1888 was 2,381,000 gallons. The original sources of supply were Ashley and Wright

ponds. Tannery and Whiting Street brooks have since been added. The ponds are natural and at the same level, and are divided from each other only by a road. Free communication between them is established by a culvert. The gate-house for drawing water from both ponds is located at Wright Pond. Ashley Pond has an area of 185 acres and a maximum depth of 25 feet, of which 12 to 13 feet of water can be drawn off. Wright Pond has an area of 45 acres. Both ponds have muddy bottoms and swamps on their borders. A small storage reservoir was built in 1883 on Bray Brook, which flows into Wright Pond. This reservoir has an area of 20 acres and a capacity of 70,000,000 gallons.

Tannery Brook was added in 1881 by building a small dam across it and diverting its water through a ten-inch pipe into the main pipe leading from the ponds to the city.

Whiting Street Brook was added in 1884 by building a dam which flows an area of about one acre, and by laying a pipe to connect the reservoir thus formed with the pipe system already in use. The dam at Whiting Street Brook is between 30 and 40 feet above the level of the surface of Wright Pond, so that when water is supplied from the brook in excess of the amount consumed in the city it may flow back into the pond through the pipe leading from it. A dam is now being built on the brook to flow 114 acres to an average depth of about 16 feet. The dam is 25 feet high at the highest point, with overflow 20 feet high. The greater portion of the bottom of the new reservoir was formerly a meadow, some portions of which were swampy.

The watersheds of all of the sources are generally hilly and rough, being mostly pasture and woodland, though some portions are cultivated. The population on the watersheds is small.

The area of the combined watersheds of the ponds and Tannery Brook is 1,726 acres; of Whiting Street Brook 857 acres. Total area of watersheds supplying the city, 2,583 acres. Water is distributed through cast-iron mains and enameled wrought-iron service pipes.

In the autumn and winter of 1875 and 1876 the water of Ashley and Wright ponds was affected by a very disagreeable, fishy taste and odor. A similar condition of the water has been noticed several times since 1876, but since 1881 there has been no recurrence of the trouble.

Chemical Examination of Water from Tannery Brook, Holyoke.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.		Nitrates.	Nitrites.
	1887.												
198	June 24	June 25	Slight.	Considerable.	1.30	8.35	3.22	5.13	.0078	.0622	.15	.0130	–
401	July 25	July 26	Very slight	Very slight, earthy.	0.70	8.35	1.65	6.70	.0040	.0229	.13	.0130	–
624	Aug. 25	Aug. 27	None.	None.	0.70	8.10	1.15	6.95	.0016	.0210	.07	.0070	–
822	Sept. 20	Sept. 21	None.	Slight.	0.00	7.90	0.50	7.40	.0004	.0063	.09	.0030	–
1041	Oct. 25	Oct. 26	None.	Sli't, earthy and floc't.	0.00	8.05	0.75	7.30	.0010	.0056	.11	.0300	–
1266	Nov. 28	Nov. 29	Slight.	Slight.	1.10	8.25	2.40	5.85	.0014	.0270	.10	.0080	–
1506	Dec. 27	Dec. 31	Slight.	M'ch, earthy and floc't.	0.20	8.70	1.05	7.65	.0046	.0189	.18	.0080	.0001
	1888.												
1685	Jan. 25	Jan. 26	Slight.	Very slight.	0.05	8.25	0.80	7.45	.0010	.0146	.13	.0100	.0001
1895	Feb. 27	Feb. 28	Distinct.	Very slight.	0.50	6.55	1.35	5.20	.0028	.0202	.12	.0090	.0000
2098	Mar. 26	Mar. 27	Very slight.	Very slight.	0.40	6.45	0.55	5.90	.0010	.0118	.11	.0070	.0002
2315	Apr. 25	Apr. 27	Slight.	None.	0.20	6.25	0.85	5.40	.0016	.0092	.10	.0040	.0002
2511	May 24	May 25	Slight.	Very slight	0.25	6.85	0.85	6.00	.0022	.0124	.08	.0040	.0002
2669	June 24	June 27	Slight.	Considerable.	1.50	6.75	2.85	3.90	.0086	.0320	.12	.0090	.0002
Av.	....	....	....	....	0.53	7.61	1.08	6.53	.0029	.0203	.11	.0096	.0001

Hardness in May, 1888, 4.0. Odor, faintly vegetable, occasionally none.——The samples were collected from Tannery Brook at the gate-house, at the surface of the water, with the exception of No. 624, which was collected inside the gate-house at about three feet beneath the surface. Heavy rains occurred just previous to the collection of Nos. 198, 401, 624 and 2669.

Microscopical Examination.

	1888.			
	March.	April.	May.	June.
1. Blue-green Algæ, ...	0.0	0.0	0.0	0.0
2. Other Algæ, ...	pr.	pr.	pr.	0.1
3. Fungi, ...	0.0	0.0	0.0	9.0
4. Animal Forms, ...	0.0	0.0	0.0	pr.

Groups and principal genera of organisms observed: 2. Palmellaceæ; Desmidiaceæ; Diatomaceæ. 3. Schizomycetes, *Crenothrix*. 4. Protozoa.

Chemical Examination of Water from Whiting Street Brook, Holyoke.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
200	June 24	June 25	Very slight.	Slight.	–	8.22	2.95	5.27	.0035	.0365	.10	.0260	–
400	July 25	July 26	None.	Very slight.	0.90	6.70	2.05	4.65	.0053	.0356	.14	.0190	–
626	Aug. 25	Aug. 27	Very slight.	None.	0.90	7.40	1.27	6.13	.0023	.0222	.14	.0070	–
823	Sept. 20	Sept. 21	Distinct.	Very slight.	0.15	9.00	0.65	8.35	.0017	.0090	.09	.0000	–
1042	Oct. 25	Oct. 26	Very slight.	Very slight.	0.30	9.05	0.45	8.60	.0018	.0120	.14	.0020	–
1267	Nov. 28	Nov. 29	Very slight.	Slight.	0.30	7.40	1.45	5.95	.0009	.0159	.16	.0250	–
1507	Dec. 27	Dec. 31	Very slight.	Sli't, earthy and floc't.	0.30	7.45	1.25	6.20	.0012	.0118	.14	.0090	.0000
	1888.												
1686	Jan. 25	Jan. 26	Slight.	Very slight.	0.20	7.95	1.20	6.75	.0016	.0104	.09	.0150	.0001
1896	Feb. 27	Feb. 28	Slight.	Slight.	0.20	5.15	1.10	4.05	.0008	.0180	.11	.0150	.0000
2100	Mar. 26	Mar. 27	Slight.	Slight, earthy.	0.15	6.05	0.65	5.40	.0023	.0268	.13	.0100	.0002
2316	Apr. 25	Apr. 27	Slight.	Very slight.	0.25	5.50	1.05	4.45	.0000	.0096	.08	.0020	.0001
2512	May 24	May 25	Slight.	Considera-ble, brown.	0.35	6.75 6.20	1.15 1.00	5.60 5.20	.0000	.0148 .0118	.08	.0040	.0002
2822	July 23	July 24	Slight.	Very slight, earthy.	0.40	8.00	0.90	7.10	.0010	.0186 .0150	.11	.0040	.0001
2999	Aug. 20	Aug. 21	Slight.	Very slight.	0.20	8.50	1.70	6.80	.0024	.0222 .0172	.11	.0030	.0003
3252	Sept. 24	Sept. 25	Very slight.	Very slight.	0.40	7.15	2.05	5.10	.0008	.0336 .0304	.10	.0150	.0002
3426	Oct. 22	Oct. 23	Slight.	Very slight.	0.45	6.75	2.00	4.75	.0010	.0218 .0216	.11	.0060	.0002
3601	Nov. 23	Nov. 24	None.	Slight.	0.20	6.60	1.20	5.40	.0000	.0122 .0112	.11	.0100	.0002
3745	Dec. 18	Dec. 19	Distinct.	Very slight.	0.00	4.50	0.40	4.10	.0004	.0130 .0106	.11	.0050	.0000
	1889.												
3884	Jan. 21	Jan. 22	Slight.	Very slight.	0.00	4.70	0.55	4.15	.0004	.0144 .0074	.13	.0030	.0001
4120	Feb. 25	Feb. 26	Distinct.	H'vy, e'rthy and floc't.	0.03	7.05	0.75	6.30	.0002	.0112 .0032	.10	.0060	.0001
4392	Mar. 25	Mar. 26	Very slight.	Considera-ble, earthy.	0.20	6.10	1.00	5.10	.0004	.0122 .0094	.09	.0050	.0001
4550	Apr. 22	Apr. 23	Very slight.	Considera-ble, earthy.	0.15	7.40	1.30	6.10	.0002	.0120 .0104	.09	.0050	.0000
4703	May 20	May 21	Slight.	Slight.	0.30	8.35	1.50	6.85	.0018	.0170 .0156	.12	.0080	.0002
Av.	....	....	....	....	0.29	7.22	1.27	5.95	.0013	.0179	.11	.0089	.0001

Hardness in May, 1888, 3.5. Odor, very faint or none, seldom vegetable. —— The samples were collected from the brook at the gate-house, at the surface of the water, with the exception of Nos. 200 and 626, which were collected five feet and two feet, respectively, below the surface. There were heavy rains just previous to the collection of Nos. 200, 400 and 626.

Microscopical Examination.

	1888.						1889.				
	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ,	0.0	0.0	0.0	0.0	0.0	0.0	0.0	pr.	0.0	0.0	0.0
2. Other Algæ,	1.0	0.7	pr.	0.2	0.2	2.1	0.7	1.4	1.5	2.9	20.4
3. Fungi,	pr.	0.4	0.0	0.1	pr.	0.0	0.0	0.0	0.0	0.0	20.0
4. Animal Forms,	pr.	0.4	pr.	0.0	0.0	pr.	0.2	2.0	0.0	0.0	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ, *Scenedesmus;* Desmidiaceæ; Diatomaceæ, *Fragillaria*, *Stephanodiscus*, *Synedra*. 3. Schizomycetes, *Crenothrix*. 4. Protozoa, *Dinobryon;* Spongiaria; Rotifera; Bryozoa; Entomostraca.

Chemical Examination of Water from Wright and Ashley Ponds, Holyoke.

[Parts per 100,000.]

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.
	1887.												
199	June 24	June 25	Slight.	Slight.	0.00	5.05	1.05	4.00	.0022	.0142	.17	.0000	–
399	July 25	July 26	Very slight.	Very slight, earthy.	0.00	4.67	0.65	4.02	.0018	.0163	.14	.0000	–
625	Aug. 25	Aug. 27	Distinct.	None.	0.10	5.12	0.72	4.40	.0014	.0177	.10	.0030	–
824	Sept. 20	Sept. 21	Slight.	Slight.	0.08	5.55	0.95	4.60	.0001	.0164	.09	.0000	–
1043	Oct. 25	Oct. 26	Slight.	Slight.	0.20	5.50	0.85	4.65	.0052	.0277	.11	.0000	–
1268	Nov. 28	Nov. 29	Slight.	Slight.	0.10	5.25	0.95	4.30	.0025	.0170	.13	.0050	–
1508	Dec. 27	Dec. 31	Slight.	Con., earthy and floc't.	0.10	5.60	1.05	4.55	.0069	.0323	.14	.0030	.0001
	1888.												
1687	Jan. 25	Jan. 26	Slight.	Very slight.	0.00	5.45	0.85	4.60	.0043	.0136	.11	.0100	.0000
1894	Feb. 27	Feb. 28	Slight.	Very slight.	0.10	5.25	0.70	4.55	.0037	.0223	.15	.0080	.0001
2099	Mar. 26	Mar. 27	Slight.	Slight, white.	0.10	5.15	0.60	4.55	.0019	.0209	.14	.0060	.0000
2317	Apr. 25	Apr. 27	Distinct.	Slight.	0.10	4.75	0.70	4.05	.0014	.0134	.11	.0040	.0003
2510	May 24	May 25	Distinct.	Very slight.	0.10	4.85	0.75	4.10	.0004	.0124	.11	.0030	.0000
2670	June 24	June 27	Very slight.	Very slight.	0.00	4.75	0.65	4.10	.0032	.0162 .0130	.12	.0050	.0000
2823	July 23	July 24	Slight.	Slight, green.	0.00	4.70	1.00	3.70	.0020	.0186 .0156	.09	.0060	.0001
2998	Aug. 20	Aug. 21	Very slight.	Very slight.	0.00	5.25	1.45	3.80	.0022	.0312 .0228	.18	.0020	.0001
3425	Oct. 22	Oct. 23	Slight.	Very slight.	0.05	4.95	0.95	4.00	.0064	.0176 .0114	.11	.0030	.0000
3602	Nov. 23	Nov. 24	Distinct.	Slight.	0.00	5.15	0.85	4.30	.0006	.0190 .0162	.11	.0070	.0003
3744	Dec. 18	Dec. 19	Slight.	Consid'ble, earthy.	0.20	2.70	0.55	2.15	.0000	.0110 .0086	.10	.0050	.0000

Chemical Examination of Water from Wright and Ashley Ponds — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
3883	Jan. 21	Jan. 22	Very slight.	Con., fibr's and black.	0.15	5.90	0.45	5.45	.0002	.0106 .0042	.11	.0200	.0000
4119	Feb. 25	Feb. 26	Slight.	Slight.	0.00	6.50	0.85	5.65	.0002	.0216 .0160	.13	.0030	.0001
4393	Mar. 25	Mar. 26	Very slight.	Very slight.	0.00	4.65	0.70	3.95	.0010	.0172 .0142	.13	.0020	.0000
4551	Apr. 22	Apr. 23	Very slight.	Slight.	0.00	4.85	0.80	4.05	.0020	.0184 .0156	.13	.0030	.0000
4702	May 20	May 21	Very slight	Slight.	0.00	4.95	0.90	4.05	.0026	.0166 .0126	.12	.0020	.0000
Av.	....	....	....	....	0.06	5.18	0.82	4.36	.0023	.0184	.12	.0043	.0001

Hardness in May, 1888, 1.8. Odor, very faint or none, occasionally vegetable, seldom mouldy. —— The samples were collected from Wright Pond, with the exception of Nos. 399, 1894, 3425 and 3744, which were collected from Ashley Pond. All samples were collected near the surface. Heavy rains occurred just previous to the collection of Nos. 199, 399 and 625. The rain of July 23 and 24, 1887, raised the pond 3 inches in 48 hours.

Microscopical Examination.

	1888. June.	July.	Aug.	Oct.	Nov.	Dec.	1889. Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ,	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ,	0.8	0.3	pr.	4.2	28.6	0.1	0.1	1.5	0.3	0.6	2.0
3. Fungi,	0.0	pr.	0.0	pr.	0.0	0.0	0.0	pr.	0.0	0.0	0.0
4. Animal Forms,	0.3	0.0	pr.	0.1	0.8	0.0	0.1	8.4	0.8	0.3	1.1

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Melosira*, *Synedra*. 3. Schizomycetes. 4. Protozoa, *Dinobryon*; Spongiaria; Hydrozoa; Rotifera; Entomostraca.

Chemical Examination of Water from a Faucet in the City of Holyoke supplied from the Holyoke Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
201	June 24	June 25	Decided.	Consid'ble.	–	7.00	2.40	4.60	.0010	.0336	.11	.0190	–
397	July 25	July 26	None.	Consid'ble, earthy.	1.70	8.97	2.75	6.22	.0017	.0496	.12	.0260	–
614	Aug. 25	Aug. 26	Slight.	Very slight.	0.70	7.37	1.60	5.77	.0007	.0258	.09	.0130	–

Chemical Examination of Water from a Faucet in the City of Holyoke supplied from the Holyoke Water Works — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
825	Sept. 20	Sept. 21	Slight.	Slight.	0.08	5.90	0.50	5.40	.0000	.0148	.08	.0000	-
1044	Oct. 25	Oct. 26	Slight.	Slight.	0.25	6.45	0.95	5.50	.0050	.0168	.12	.0020	-
1269	Nov. 28	Nov. 29	Decided.	Much, brown.	0.30	6.85	1.50	5.35	.0022	.0230	.15	.0090	-
1488	Dec. 27	Dec. 28	Very slight.	None.	0.10	6.75	1.10	5.65	.0010	.0126	.13	.0080	.0003
	1888.												
1688	Jan. 25	Jan. 26	Slight.	Very slight.	0.10	5.95	0.70	5.25	.0024	.0092	.10	.0070	.0000
1897	Feb. 27	Feb. 28	Slight.	Very slight.	0.25	6.05	1.00	5.05	.0002	.0118	.10	.0080	.0000
2101	Mar. 26	Mar. 27	Slight.	Slight.	0.10	5.95	0.85	5.10	.0000	.0100	.12	.0060	.0000
2307	Apr. 25	Apr. 26	Slight.	Sli't, brown.	0.15	6.65	1.10	5.55	.0000	.0143	.10	.0040	.0003
2513	May 24	May 25	Distinct.	Slight.	0.25	6.55	0.65	5.90	.0000	.0114	.07	.0030	.0002
Av.	....	....	....	....	0.36	6.70	1.26	5.44	.0012	.0194	.11	.0088	.0001

Hardness in May, 1888, 3.6. Odor, very faint or none, seldom vegetable.——The samples were collected from a faucet in the office of the Holyoke Water Power Company. There were heavy rains from two to four days previous to the collection of Nos. 201, 397, 61 and 1269.

Microscopical Examination.

	1888. Mar.	1888. Apr.	1888. May.
1. Blue-green Algæ, ...	0.0	0.0	0.0
2. Other Algæ, ...	pr.	pr.	pr.
3. Fungi, ...	0.0	pr.	0.0
4. Animal Forms, ...	pr.	pr.	0.0

Groups and principal genera of organisms observed: 2. Palmellaceæ; Diatomaceæ. 4. Protozoa, *Dinobryon.*

Water Supply of Hopedale.

This town is supplied jointly with Milford by the Milford Water Company. *See Milford.*

Water Supply of Hopkinton.

Description of Works. — Population in 1885, 3,922. The works are owned by the town. Water was introduced in 1884. The average daily consumption in 1887 was about 25,000 gallons. The sources of supply are three tubular wells, each 6 inches in diameter.

Well No. 1 is 59 feet deep, well No. 2 is 65 feet deep, and well No. 3 is 75 feet deep. They are sunk in rock which comes within 10 feet of the surface of the ground, not far from the summit of a large hill. There are 44 houses on this hill within 1,000 feet of the pumping station. Pumps force the water from the wells to an open iron tank 35 feet in diameter and 35 feet high. Distributing mains are of cast iron and service pipes of wrought iron.

Chemical Examination of Water from the Tubular Wells of the Hopkinton Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
159	June 21	June 22	None.	None.	0.00	13.75	-	-	.0003	.0024	1.26	.1040	-
375	July 21	July 21	None.	None.	0.00	22.50	-	-	.0001	.0019	2.64	.5900	-
590	Aug. 22	Aug. 23	None.	None.	0.00	18.25	-	-	.0000	.0014	2.49	.5200	-
764	Sept. 14	Sept. 15	None.	None.	0.00	12.00	-	-	.0000	.0008	1.16	.3900	-
1335	Dec. 6	Dec. 7	Slight, milky.	None.	0.00	12.15	-	-	.0000	.0018	1.42	.4000	-
1469	Dec. 21	Dec. 22	Very slight.	Very slight.	0.00	14.00	-	-	.0000	.0018	1.91	.3750	.0002
	1888.												
1675	Jan. 24	Jan. 24	None.	None.	0.00	13.20	-	-	.0000	.0020	1.74	.5200	.0000
1887	Feb. 24	Feb. 25	None.	None.	0.00	13.35	-	-	.0002	.0012	1.85	.4800	.0000
2071	Mar. 21	Mar. 22	None.	None.	0.00	12.75	-	-	.0004	.0018	1.88	.3500	.0000
2286	Apr. 23	Apr. 24	Slight, milky.	None.	0.00	17.10	-	-	.0000	.0028	2.88	.4500	.0002
2489	May 22	May 23	None.	None.	0.00	12.30	-	-	.0000	.0012	1.49	.3250	.0000
Av.	....	....	....	....	0.00	14.67	-	-	.0001	.0017	1.88	.4095	.0001

Hardness in December, 1887, 5.0; in May, 1888, 4.7. Odor, none.—— The samples were collected from a faucet in the village, and represent a mixture of the water from the three wells.

Microscopical Examination.

	1888. March.	1888. April.	1888. May.
1. Blue-green Algæ,	0.0	0.0	0.0
2. Other Algæ,	pr.	pr.	pr.
3. Fungi,	0.0	0.0	0.0
4. Animal Forms,	0.0	0.0	0.0

Groups and principal genera of organisms observed: 2. Palmellaceæ; Zoosporeæ; Diatomaceæ.

Chemical Examination of Water from Well No. 1, Hopkinton Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance: Turbidity.	Appearance: Sediment.	Appearance: Color.	Residue on Evaporation: Total.	Residue on Evaporation: Loss on Ignition.	Residue on Evaporation: Fixed.	Ammonia: Free.	Ammonia: Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
1332	Dec. 6	Dec. 7	Slight, milky.	Very slight.	0.0	23.80	–	–	.0010	.0018	4.38	.8200	–
1466	Dec. 21	Dec. 22	Very slight.	Very slight.	0.0	26.00	–	–	.0000	.0008	4.95	.8000	–
Av.	....	....	....	....	0.0	24.90	–	–	.0005	.0013	4.67	.8100	–

Hardness, Dec. 6, 10.6. Odor, none. —— The samples were collected from a faucet at the well while pumping.

Chemical Examination of Water from Well No. 2, Hopkinton Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance: Turbidity.	Appearance: Sediment.	Appearance: Color.	Residue on Evaporation: Total.	Residue on Evaporation: Loss on Ignition.	Residue on Evaporation: Fixed.	Ammonia: Free.	Ammonia: Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
972	Oct. 17	Oct. 19	None.	Very slight.	0.0	20.90	–	–	.0000	.0016	4.20	.5200	–
1333	Dec. 6	Dec. 7	Very slight, milky.	None.	0.0	22.20	–	–	.0008	.0008	5.26	.6500	–
1467	Dec. 21	Dec. 22	None.	None.	0.0	20.30	–	–	.0000	.0010	4.70	.4000	.0002
Av.	....	....	....	....	0.0	21.13	–	–	.0003	.0011	4.72	.5233	–

Hardness, Dec. 6, 7.8. Odor, none. —— The samples were collected from a faucet at the well while pumping.

Chemical Examination of Water from Well No. 3, Hopkinton Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance: Turbidity.	Appearance: Sediment.	Appearance: Color.	Residue on Evaporation: Total.	Residue on Evaporation: Loss on Ignition.	Residue on Evaporation: Fixed.	Ammonia: Free.	Ammonia: Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
1236	Nov. 21	Nov. 22	None.	None.	0.0	9.70	–	–	.0000	.0024	0.93	.3000	–
1334	Dec. 6	Dec. 7	Very slight, milky.	Slight.	0.0	10.70	–	–	.0010	.0008	1.20	.3000	–
1468	Dec. 21	Dec. 22	None.	Slight.	0.0	10.40	–	–	.0000	.0010	1.20	.3000	.0002
Av.	....	....	....	....	0.0	10.27	–	–	.0003	.0014	1.11	.3000	–

Hardness, Dec. 6, 4.4. Odor, none. —— The samples were collected from a faucet at the well while pumping.

Water Supply of Hudson.

Description of Works. — Population in 1885, 3,968. The works are owned by the town. Water was introduced in 1884. There were about 422 service taps supplied in 1888. The source of supply is Gates Pond, in Berlin. Area of pond, 75 acres; average depth, 30 feet; maximum depth, 80 feet; bottom, sandy. There is no shallow flowage and the shores are abrupt. The drainage area, of 310 acres exclusive of the pond, consists of pasture and woodland, and a very little cultivated land; it is uninhabited. Water is distributed by gravity. Distributing mains and service pipes are of wrought iron lined with cement.

Chemical Examination of Water from Gates Pond in Berlin.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1887.												
175	June 22	June 23	Decided.	Slight.	0.05	3.32	0.82	2.50	.0027	.0168	.21	.0000	–
412	July 26	July 27	None.	Very slight.	0.10	4.05	0.60	3.45	.0003	.0130	.23	.0100	–
617	Aug. 25	Aug. 27	Very slight.	None.	0.00	3.80	0.75	3.05	.0010	.0147	.19	.0100	–
859	Sept. 29	Sept. 30	Very slight.	None.	0.05	2.95	0.80	2.15	.0012	.0138	.19	.0000	–
995	Oct. 20	Oct. 21	Very slight.	Very slight, white.	0.00	2.70	0.40	2.30	.0000	.0120	.20	.0030	–
1257	Nov. 28	Nov. 29	Slight.	Very slight, white.	0.10	2.80	0.80	2.00	.0018	.0178	.24	.0080	–
1505	Dec. 29	Dec. 30	Very slight.	Very slight.	0.10	2.55	0.80	1.75	.0026	.0172	.22	.0070	–
	1888.												
1698	Jan. 26	Jan. 27	Slight.	Slight.	0.05	2.75	0.75	2.00	.0032	.0122	.16	.0080	.0000
1907	Feb. 27	Feb. 28	Slight.	Slight.	0.00	2.90	0.70	2.20	.0020	.0122	.22	.0100	.0003
2097	Mar. 24	Mar. 26	Distinct.	Slight.	0.10	2.85	0.60	2.25	.0000	.0206	.20	.0050	.0000
2302	Apr. 24	Apr. 25	Distinct.	Slight.	0.05	2.60	0.55	2.05	.0005	.0120	.22	.0070	.0001
2514	May 24	May 25	Slight.	Very slight.	0.05	2.85	0.60	2.25	.0006	.0152	.17	.0050	.0003
2659	June 28	June 29	Decided.	Slight, green.	0.05	2.48	0.68	1.80	.0000	.0184 .0184	.21	.0020	.0000
2790	July 18	July 18	Slight, milky.	Slight.	0.10	2.50	0.75	1.75	.0000	.0194 .0154	.19	.0020	.0000
3003	Aug. 21	Aug. 22	Slight.	Slight, brown.	0.10	2.50	0.70	1.80	.0004	.0180 .0156	.18	.0000	.0002
3272	Sept. 27	Sept. 27	Very slight.	Slight, white.	0.10	2.45	0.85	1.60	.0000	.0160 .0150	.18	.0030	.0002

Chemical Examination of Water from Gates Pond in Berlin — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
3427	Oct. 23	Oct. 24	Distinct.	Slight, white.	0.10	2.30	0.60	1.70	.0056	.0192 .0160	.20	.0040	.0001
3605	Nov. 24	Nov. 24	Slight.	Slight, white.	0.00	2.20	0.75	1.45	.0022	.0160 .0132	.19	.0100	.0000
3757	Dec. 19	Dec. 20	Very slight.	Slight.	0.00	2.25	0.75	1.50	.0034	.0106 .0086	.20	.0100	.0001
	1889.												
3888	Jan. 22	Jan. 22	Distinct.	Very slight.	0.05	2.15	0.40	1.75	.0010	.0134 .0104	.22	.0080	.0001
4048	Feb. 20	Feb. 21	Very slight.	Very slight.	0.05	2.35	0.90	1.45	.0026	.0140 .0096	.20	.0060	.0000
4231	Mar. 7	Mar. 7	Slight.	Slight.	0.00	2.15	0.40	1.75	.0006	.0150 .0104	.19	.0060	.0000
4469	Apr. 5	Apr. 6	Distinct.	Very slight.	0.00	1.95	0.50	1.45	.0014	.0178 .0144	.18	.0060	.0001
4620	May 7	May 7	Slight.	Slight, white.	0.00	2.10	0.70	1.40	.0002	.0156 .0118	.18	.0040	.0001
Av.	....	....	....	....	0.05	3.01	0.68	2.33	.0014	.0155	.20	.0056	.0001

Hardness in May, 1888, 1.7. Odor, very faint or none, seldom vegetable.—— Samples numbered 175 to 2514 were collected from a faucet in the village. The remaining samples were collected from the pond.

Microscopical Examination.

	1888. June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	1889. Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ, ...	pr.	0.1	0.2	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	0.7	0.9	2.9	0.8	6.0	3.4	0.1	4.3	0.1	17.1	3.6	0.3
3. Fungi, ...	0.0	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, ...	0.1	2.5	3.6	1.7	0.5	1.0	4.0	0.8	5.0	2.2	1.0	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ, *Chlorococcus*; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Asterionella*, *Melosira*, *Tabellaria*; Zygnemaceæ. 3. Schizomycetes. 4. Protozoa, *Dinobryon*; Spongiaria; Rotifera; Entomostraca.

Water Supply of Hull.

This town is supplied jointly with Hingham by the Hingham Water Company. *See Hingham.*

WATER SUPPLY OF HYDE PARK. — HYDE PARK WATER COMPANY.

Description of Works. — Population in 1885, 8,376. The works are owned by the Hyde Park Water Company, and were built in 1885. The sources of supply are tubular wells sunk near the Neponset River to a depth of 34 to 38 feet. There were 64 two-inch tubular wells connected with the pumps in 1887, and others have been added since that time. The pumps force the water to an open distributing reservoir, having a capacity of 1,500,000 gallons. It is 150 feet square at the top and the water is 14 feet deep when it is full. The bottom is of concrete and the slopes are paved. The reservoir is on the opposite side of the village from the pumping station and is reached by a single line of pipe, so that only the surplus from pumping goes to the reservoir. The water enters it at one side and is drawn out at the other. The growth of algæ in the water of the reservoir has affected its quality to such an extent that, beginning March 8, 1889, continuous pumping was resorted to, and the use of the reservoir was discontinued except in case of fires or other emergencies. The analyses of water from the reservoir after March 8, 1889, do not, therefore, indicate the quality of the water supplied to the town. Distributing mains are of cast iron and service pipes of wrought iron lined with cement.

Chemical Examination of Water from the Tubular Wells of the Hyde Park Water Company.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1887.												
82	June 11	June 11	None.	None.	0.0	6.00	–	–	.0005	.0007	.69	.1040	–
298	July 11	July 11	None.	None.	0.0	6.10	–	–	.0000	.0010	.81	.0390	–
513	Aug. 9	Aug. 10	None.	None.	0.0	7.17	–	–	.0000	.0015	.86	.1040	–
723	Sept. 9	Sept. 9	None.	None.	0.0	7.35	–	–	.0000	.0008	.84	.0390	–
927	Oct. 11	Oct. 11	None.	None.	0.0	6.45	–	–	.0000	.0016	.83	.0780	–
1134	Nov. 9	Nov. 10	Very slight.	None.	0.0	6.65	–	–	.0008	.0004	.81	.0550	–
1385	Dec. 12	Dec. 13	None.	None.	0.0	6.95	–	–	.0014	.0024	.92	.0700	–

Chemical Examination of Water from the Tubular Wells of the Hyde Park Water Company — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
1573	Jan. 10	Jan. 11	None.	None.	0.0	5.80	–	–	.0000	.0010	.75	.0800	.0001
1803	Feb. 10	Feb. 13	None.	None.	0.0	6.30	–	–	.0000	.0016	.81	.0700	.0000
*1985	Mar. 9	Mar. 10	None.	None.	0.0	5.90	–	–	.0004	.0018	.69	.0650	.0001
2185	Apr. 9	Apr. 11	None.	None.	0.0	4.65	–	–	.0000	.0004	.56	.0350	.0001
2370	May 8	May 8	None.	None.	0.0	5.20	–	–	.0000	.0010	.62	.0800	.0000
2720	July 5	July 6	None.	None.	0.0	6.43	–	–	.0002	.0062	.76	.1000	.0002
2895	Aug. 8	Aug. 9	None.	None.	0.0	6.80	–	–	.0000	.0028	.85	.0450	.0001
3159	Sept. 11	Sept. 12	None.	None.	0.0	7.20	–	–	.0002	.0026	.91	.0550	.0007
3349	Oct. 10	Oct. 11	None.	None.	0.0	6.60	–	–	.0008	.0050	.80	.0500	.0003
3537	Nov. 13	Nov. 14	None.	None.	0.0	5.75	–	–	.0000	.0012	.72	.0650	.0003
3760	Dec. 19	Dec. 20	None.	None.	0.0	6.05	–	–	.0000	.0014	.73	.0600	.0002
	1889.												
3834	Jan. 8	Jan. 10	None.	None.	0.0	5.80	–	–	.0002	.0018	.69	.0680	.0002
4027	Feb. 15	Feb. 18	None.	None.	0.0	5.10	–	–	.0000	.0024	.64	.0420	.0003
4307	Mar. 13	Mar. 15	Very slight.	None.	0.0	5.85	–	–	.0000	.0012	.68	.0780	.0001
4475	Apr. 8	Apr. 9	Slight.	Slight.	0.0	5.90	–	–	.0000	.0024	.69	.0500	.0001
4623	May 7	May 8	None.	None.	0.0	6.15	–	–	.0002	.0016	.69	.0600	.0000
Av.	....	....	....	....	0.0	6.10	–	–	.0002	.0019	.75	.0649	.0002

Hardness, July, 1887, 3.4; in May, 1888, 2.2. Odor, none.—— The samples were collected from a faucet at the pumping station while pumping.

Microscopical Examination.

	1888. Apr.	May.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	1889. Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ, ...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	pr.
2. Other Algæ, ...	0.0	0.0	0.0	0.0	0.0	pr.	0.1	0.0	0.0	0.0	1.1	0.0	0.0
3. Fungi, ...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, . . .	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Diatomaceæ. 4. Protozoa.

Chemical Examination of Water from the Distributing Reservoir of the Hyde Park Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
84	June 10	June 11	Slight, milky.	Slight.	0.00	6.30	–	–	.0018	.0078	.70	.0520	–
296	July 11	July 11	Slight.	None.	0.00	5.75	–	–	.0002	.0130	.70	.0330	–
512	Aug. 9	Aug. 10	None.	None.	0.00	6.25	–	–	.0017	.0092	.81	.0520	–
722	Sept. 9	Sept. 9	Slight.	Very slight.	0.00	7.65	–	–	.0000	.0080	.79	.0200	–
928	Oct. 11	Oct. 11	Distinct.	Slight.	0.10	6.45	–	–	.0004	.0238	.75	.0260	–
1135	Nov. 9	Nov. 10	Distinct.	Slight, white.	0.00	6.75	–	–	.0000	.0180	.82	.0400	–
1386	Dec. 12	Dec. 13	Decided.	Considerable, white.	0.20	7.15	–	–	.0010	.0184 .0088	.88	.0400	–
	1888.												
1572	Jan. 10	Jan. 11	Distinct.	Slight.	0.00	7.45	–	–	.0000	.0160	.76	.0650	.0005
1802	Feb. 10	Feb. 13	Distinct, milky.	Very slight, white.	0.10	7.05	–	–	.0000	.0127	.76	.0500	.0005
1984	Mar. 9	Mar. 10	Distinct.	Slight, white.	0.10	6.70	–	–	.0000	.0173	.72	.0500	.0003
2184	Apr. 9	Apr. 11	Decided.	Very slight.	0.10	5.80	–	–	.0004	.0252	.68	.0250	.0007
2369	May 8	May 8	Decided.	Slight, green.	0.00	5.50	–	–	.0000	.0230 .0062	.61	.0180	.0001
2719	July 5	July 6	Slight.	Slight, white.	0.00	5.30	–	–	.0036	.0210 .0110	.70	.0070	.0002
2896	Aug. 8	Aug. 9	Distinct.	Very slight.	0.00	6.40	–	–	.0012	.0172 .0124	.76	.0120	.0001
3160	Sept. 11	Sept. 12	Slight.	Slight, white.	0.00	6.50	–	–	.0020	.0214 .0126	.78	.0050	.0002
3348	Oct. 10	Oct. 11	Distinct.	Considerable, green.	0.00	5.95	–	–	.0010	.0252 .0120	.81	.0350	.0002
3536	Nov. 13	Nov. 14	Slight.	Considerable, green.	0.00	6.20 5.10	–	–	.0010	.0258 .0134	.75	.0250	.0001
3759	Dec. 19	Dec. 20	Distinct.	Slight, green.	0.00	5.80 5.05	–	–	.0002	.0182 .0072	.66	.0250	.0002
	1889.												
3835	Jan. 8	Jan. 10	Distinct.	Con., yellow green.	0.00	4.85 4.55	–	–	.0012	.0162 .0058	.56	.0270	.0002
4028	Feb. 15	Feb. 18	Decided.	Heavy, green.	0.00	5.80 4.80	–	–	.0004	.0228 .0034	.63	.0300	.0002
4355	Mar. 19	Mar. 21	Decided.	Heavy, green.	0.00	5.90 4.85	–	–	.0006	.0236 .0058	.66	.0380	.0003
4518	Apr. 16	Apr. 17	Decided.	Slight.	0.00	5.65	–	–	.0010	.0164 .0106	.67	.0350	.0004
4624	May 7	May 8	Very slight.	Very slight.	0.00	6.20	–	–	.0024	.0106	.68	.0600	.0001
Av.	....	....	....	....	0.03	6.27	–	–	.0009	.0179	.72	.0335	.0003

Hardness in May, 1888, 2.3. Odor, generally vegetable, frequently disagreeable, occasionally none. —— The samples were collected from the reservoir. The reservoir was shut off from the town on March 8, 1889, and since this date water has been supplied directly from the wells by continuous pumping. In May the reservoir was drawn off and cleaned, and was being refilled when sample No. 4624 was collected, there being about three feet of water in it at the time.

Microscopical Examination.

	1888.						1889.				
	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ,	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ,	65.1	9.0	771.1	121.0	1006.7	169.6	2406.0	3270.4	3276.1	115.0	0.7
3. Fungi,	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms,	0.3	0.7	0.1	pr.	pr.	16.0	1.2	0.0	0.0	0.2	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ, *Chlorococcus*, *Protococcus*; Zoosporeæ, *Cœlastrum*, *Pandorina*, *Raphidium*, *Scenedesmus*; Desmidiaceæ, *Closterium*; Diatomaceæ, *Asterionella*, *Synedra*; Volvocineæ. 3. Schizomycetes. 4. Protozoa, *Dinobryon*; Rotifera; Entomostraca.

Chemical Examination of Water from Neponset River at Hyde Park.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
83	June 10	June 11	Slight.	Consid'ble.	2.00	6.80	3.00	3.80	.0044	.0487	0.68	.0070	–
297	July 11	July 11	Slight.	None.	1.00	5.95	1.75	4.20	.0069	.0432	0.58	.0000	–
511	Aug. 9	Aug. 10	Very slight.	Much, rusty brown.	1.60	9.07	2.55	6.52	.0062	.0509	0.93	.0070	–
721	Sept. 9	Sept. 9	Very slight.	Slight.	0.70	7.37	1.72	5.65	.0039	.0256	0.74	.0130	–
926	Oct. 11	Oct. 11	Decided.	Slight.	0.80	8.75	1.50	7.25	.0094	.0370	1.28	.0100	–
1133	Nov. 9	Nov. 10	Decided.	Slight.	1.00	11.25	2.80	8.45	.0009	.0358	1.66	.0090	–
1384	Dec. 12	Dec. 13	Distinct.	Con., e'rthy and floc't.	1.20	9.25	2.75	6.50	.0056	.0388	1.09	.0100	–
	1888.												
1656	Jan. 19	Jan. 23	Distinct.	Consid'ble, earthy.	1.00	7.30	2.65	4.65	.0011	.0303	0.67	.0200	.0000
1801	Feb. 10	Feb. 13	Distinct.	Con., e'rthy and floc't.	0.70	6.55	2.60	3.95	.0007	.0283	0.65	.0200	.0000
1983	Mar. 9	Mar. 10	Decided.	Con., e'rthy and floc't.	0.90	7.90	2.45	5.45	.0046	.0372	0.88	.0120	.0003
2183	Apr. 9	Apr. 11	Slight.	Slight, brown.	0.90	4.30	1.65	2.65	.0008	.0288	0.52	.0050	.0000
2368	May 8	May 8	Distinct.	Consid'ble, brown.	1.40	5.85	2.45	3.40	.0056	.0314	0.56	.0080	.0003
2721	July 5	July 6	Slight.	Slight, brown.	0.60	6.70	2.10	4.60	.0052	.0286	0.94	.0070	.0003
2897	Aug. 8	Aug. 9	Slight.	Slight, brown.	0.80	8.95	2.10	6.85	.0034	.0446 .0432	1.42	.0070	.0004
3158	Sept. 11	Sept. 12	Very slight.	Slight, brown.	1.10	11.20	2.55	8.65	.0098	.0430 .0378	1.83	.0090	.0005
3347	Oct. 10	Oct. 11	Very slight.	Slight.	1.50	6.35	2.75	3.60	.0008	.0350 .0328	0.63	.0080	.0002

Chemical Examination of Water from Neponset River at Hyde Park—Concluded.

Number.	Date of Collection.	Date of Exam-ination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albu-minoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
3535	Nov. 13	Nov. 14	Very slight.	Sli't, e'rthy and floc't.	1.60	5.65	2.35	3.30	.0006	.0344 .0294	0.59	.0060	.0002
3758	Dec. 19	Dec. 20	Slight.	Sli't, e'rthy and floc't.	0.70	3.70	1.35	2.35	.0000	.0150 .0130	0.43	.0030	.0006
	1889.												
3833	Jan. 8	Jan. 10	Slight.	Slight.	0.60	3.60	1.15	2.45	.0006	.0188 .0164	0.47	.0050	.0001
4026	Feb. 15	Feb. 18	Decided.	Slight, earthy.	0.50	5.65	1.55	4.10	.0008	.0254 .0180	0.75	.0110	–
4306	Mar. 13	Mar. 15	Slight.	Very slight.	0.70	5.00	2.00	3.00	.0004	.0240 .0198	0.60	.0030	.0002
4474	Apr. 8	Apr. 9	Distinct.	Consid'ble.	0.60	4.70	1.65	3.05	.0020	.0276 .0236	0.65	.0040	.0002
4622	May 8	May 8	Slight.	Consid'ble.	1.70	5.55	2.50	3.05	.0122	.0392 .0338	0.56	.0040	.0002
Av.	....	....	....	....	1.07	7.53	2.32	5.21	.0037	.0335	0.83	.0082	.0002

Hardness in May, 1888, 1.9. Odor, vegetable, often mouldy. The samples were collected from the Neponset River near the pumping station of the Hyde Park Water Company.

Microscopical Examination.

	1888. July.	Aug.	Sept.	Oct.	Nov.	Dec.	1889. Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ, ...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	0.5	0.9	pr.	0.4	0.2	0.0	0.7	1.0	0.0	2.7	1.2
3. Fungi, ...	4.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, ...	pr.	0.1	0.1	0.6	0.2	0.0	pr.	0.1	0.0	0.0	0.2

Groups and principal genera of organisms observed: 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Fragillaria, Synedra;* Zygnemaceæ. 3. Schizomycetes, *Crenothrix.* 4. Protozoa; Spongiaria.

Chemical Examination of Water from Sprague Pond, Hyde Park.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Exam-ination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albu-minoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
3575	Nov. 20	Nov. 20	Distinct, milky.	None.	0.15	7.70	1.45	6.25	.0000	.0336 .0276	1.45	.0030	.0000

Odor, distinctly vegetable. —— The sample was collected from near the lower end of the pond opposite the pier of Davenport's ice-house. The pond is located in the village of Readville.

Water Supply of Kingston.

Description of Works. — Population in 1885, 1,570. The works are owned by the town. Water was introduced in 1886. The sources of supply are a well and filter-gallery on the bank of Jones River near the village. The well is 20 feet in diameter and is covered and ventilated. The filter-gallery, built in June, 1888, is a brick arch 360 feet long, 20 inches wide and 14 inches high. It was built parallel with and near the river and is connected with the well. Pumps, operated by water power, force the water to a cylindrical distributing reservoir having a capacity of 265,000 gallons. The reservoir is 50 feet in diameter and its depth below an overflow pipe is 18 feet. The walls are built of brick masonry and the bottom is of concrete. In July, 1888, the reservoir was covered with a roof to exclude the light. When the pumps are in operation, only the water not used by the water takers goes to the reservoir, and water is drawn from it by the same pipe which feeds it. Circulation of water in the reservoir has sometimes been caused by pumping an excessive amount of water into it, thus causing the water to waste through the overflow pipe. Distributing mains are of cast iron and service pipes are of lead.

Previous to Oct. 15, 1888, there was a small system of water works in the town operated by the Kingston Aqueduct Company. The sources of supply were three wells near Jones River and a short distance below the sources of the present supply of the town. The works of the company were purchased by the town and have been discontinued.

Chemical Examination of Water from the Well and Filter-Gallery, Kingston.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
224	June 29	June 30	None.	None.	0.0	5.67	–	–	.0000	.0009	.85	.0780	–
427	July 27	July 29	None.	None.	0.0	6.15	–	–	.0000	.0002	.88	.1700	–
637	Aug. 29	Aug. 29	None.	None.	0.0	5.97	–	–	.0002	.0020	.85	.1170	–
833	Sept. 21	Sept. 22	None.	None.	0.0	5.65	–	–	.0000	.0036	.85	.1040	–
1062	Oct. 27	Oct. 28	Very slight.	Slight.	0.0	5.40	–	–	.0000	.0016	.82	.1000	–
1299	Nov. 30	Dec. 1	Very slight.	None.	0.0	6.05	–	–	.0000	.0020	.83	.1250	–
1503	Dec. 28	Dec. 29	Very slight.	Very slight.	0.0	5.75	–	–	.0001	.0023	.87	.1500	–

Chemical Examination of Water from the Well and Filter-Gallery, Kingston — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance: Turbidity.	Appearance: Sediment.	Appearance: Color.	Residue on Evaporation: Total.	Residue on Evaporation: Loss on Ignition.	Residue on Evaporation: Fixed.	Ammonia: Free.	Ammonia: Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
1740	Feb. 2	Feb. 3	None.	None.	0.0	5.50	–	–	.0000	.0018	.93	.1100	.0004
1881	Feb. 21	Feb. 23	None.	Slight, brown.	0.0	5.65	–	–	.0000	.0050	.89	.0900	.0002
2065	Mar. 20	Mar. 21	Very slight.	Slight, brown.	0.0	5.30	–	–	.0000	.0010	.87	.1100	.0004
2245	Apr. 18	Apr. 18	None.	None.	0.0	5.10	–	–	.0000	.0020	.88	.1000	.0002
2442	May 16	May 17	None.	None.	0.0	5.45	–	–	.0000	.0014	.84	.1200	.0002
2740	July 6	July 9	None.	None.	0.0	5.65	–	–	.0000	.0020	.82	.0700	.0001
2781	July 16	July 17	None.	None.	0.0	5.70	–	–	.0000	.0014	.83	.0750	.0001
3022	Aug. 22	Aug. 24	None.	None.	0.0	5.75	–	–	.0002	.0032	.76	.0750	.0001
3257	Sept. 25	Sept. 25	None.	None.	0.0	5.60	–	–	.0000	.0038	.84	.1000	.0001
3498	Nov. 6	Nov. 7	None.	None.	0.0	4.85	–	–	.0000	.0018	.83	.1000	.0001
3645	Dec. 3	Dec. 4	Distinct, milky.	Slight.	0.0	5.15	–	–	.0000	.0032	.81	.1000	.0001
3712	Dec. 13	Dec. 14	None.	None.	0.0	5.25	–	–	.0038	.0026	.85	.1000	.0002
	1889.												
3840	Jan. 9	Jan. 11	None.	None.	0.0	5.20	–	–	.0000	.0020	.79	.1200	.0000
3952	Feb. 3	Feb. 4	None.	None.	0.0	4.85	–	–	.0004	.0024	.78	.0800	.0001
4099	Feb. 22	Feb. 23	None.	None.	0.0	4.55	–	–	.0002	.0014	.75	.0600	.0003
4328	Mar. 18	Mar. 18	None.	None.	0.0	4.55	–	–	.0006	.0008	.76	.0780	.0000
4491	Apr. 10	Apr. 10	None.	None.	0.0	4.30	–	–	.0000	.0014	.78	.0550	.0000
Av.	....	....	....	....	0.0	5.39	–	–	.0002	.0021	.83	.0995	.0002

Hardness in May, 1888, 2.1. Odor, none. —— The samples were collected from a faucet at the pumping station while pumping, with the exception of No. 3840, which was collected from a faucet at the town hall.

Microscopical Examination.

	1888. June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	1889. Jan.	Feb.	Feb.	Mar.	Apr.
1. Blue-green Algæ, ...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	0.0	0.0	0.0	0.0	0.0	pr.	0.0	0.0	pr.	pr.	0.0	pr.
3. Fungi, ...	1.5	6.0	1.0	0.0	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, ...	0.0	0.0	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Groups and principal genera of organisms observed: 2. Diatomaceæ. 3. Schizomycetes, *Crenothrix*. 4. Protozoa.

Chemical Examination of Water from the Distributing Reservoir, Kingston.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.		Nitrates.	Nitrites.
	1887.												
223	June 29	June 30	Very slight.	None.	0.0	5.95	–	–	.0002	.0038	.82	.1040	–
426	July 28	July 29	Very slight.	None.	0.0	6.47	–	–	.0002	.0027	.92	.1300	–
636	Aug. 29	Aug. 29	Slight.	None.	0.0	6.10	–	–	.0006	.0088	.82	.0780	–
1063	Oct. 27	Oct. 28	Distinct.	Slight.	0.0	5.85	–	–	.0000	.0054	.80	.1000	–
1298	Nov. 30	Dec. 1	Very slight.	Very slight.	0.0	5.85	–	–	.0000	.0076	.80	.1000	–
1502	Dec. 28	Dec. 29	Distinct.	Slight, white.	0.0	6.40	–	–	.0000	.0075	.90	.1100	.0008
	1888.												
1741	Feb. 2	Feb. 3	Slight.	Slight.	0.0	6.20	–	–	.0000	.0062	.90	.1200	.0007
1880	Feb. 21	Feb. 23	None.	Very slight.	0.0	5.65	–	–	.0000	.0054	.85	.1000	.0006
2064	Mar. 20	Mar. 21	Slight.	Very slight.	0.0	5.60	–	–	.0000	.0046	.89	.1200	.0008
2244	Apr. 18	Apr. 18	Decided.	None.	0.0	5.75	–	–	.0000	.0050	.88	.1000	.0006
2443	May 16	May 17	Distinct, green.	None.	0.0	5.85	–	–	.0000	.0060	.85	.0850	.0010
2739	July 6	July 9	Slight.	Slight, white.	0.0	6.30	–	–	.0022	.0140 .0050	.84	.0700	.0010
2780	July 16	July 17	Slight.	Very slight, white.	0.0	6.30	–	–	.0004	.0164 .0044	.86	.0750	.0008
3021	Aug. 22	Aug. 24	Very slight.	Very slight.	0.0	6.05	–	–	.0026	.0056 .0034	.80	.0780	.0002
3256	Sept. 25	Sept. 25	None.	None.	0.0	6.25 5.95	–	–	.0004	.0024 .0014	.83	.0800	.0001
3499	Nov. 6	Nov. 7	None.	Very slight.	0.0	5.45	–	–	.0000	.0024 .0018	.80	.0900	.0000
3644	Dec. 3	Dec. 4	None.	None.	0.0	5.80	–	–	.0000	.0032	.81	.0900	.0000
3713	Dec. 13	Dec. 14	None.	Slight.	0.0	5.80	–	–	.0000	.0018	.84	.0800	.0000
	1889.												
3953	Feb. 3	Feb. 4	Very slight, milky.	Slight, black.	0.0	6.05	–	–	.0024	.0180	.84	.0800	.0000
4100	Feb. 22	Feb. 23	None.	Very slight.	0.0	5.90	–	–	.0000	.0026 .0018	.84	.0700	.0003
4327	Mar. 18	Mar. 18	Slight.	Slight.	0.0	5.75	–	–	.0006	.0064	.76	.0780	.0001
4492	Apr. 10	Apr. 10	Very slight.	Very slight.	0.0	4.95	–	–	.0004	.0024	.70	.0500	.0001
Av.	....	....	....	....	0.0	5.89	–	–	.0005	.0063	.83	.0904	.0004

Hardness in May, 1888, 2.1. Odor, none, except sample 3021, which was distinctly disagreeable.—— The samples were collected from the reservoir. The reservoir was being roofed over at the time sample No. 2780 was collected.

Microscopical Examination.

	1888.							1889.			
	July.	July.	Aug.	Sept.	Nov.	Dec.	Dec.	Feb.	Feb.	Mar.	Apr.
1. Blue-green Algæ,	0.0	0.0	0.0	pr.	0.0	pr.	0.0	0.0	0.0	0.0	0.0
2. Other Algæ,	11.8	1.4	0.8	0.0	0.0	pr.	0.0	0.0	0.0	0.4	0.0
3. Fungi,	0.3	0.1	0.0	pr.	0.0	pr.	0.0	0.0	0.0	0.0	0.0
4. Animal Forms,	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ, *Scenedesmus;* Desmidiaceæ; Diatomaceæ, *Synedra.* 3. Schizomycetes. 4. Protozoa.

Chemical Examination of Water from the Wells formerly used by the Kingston Aqueduct Company.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1888.												
1942	Mar. 2	Mar. 3	None.	Sli't, rusty.	0.0	6.50	–	–	.0000	.0040	1.08	.2500	.0000

Odor, none. —— The sample was collected from a faucet near the pump at the wells.

Chemical Examination of Water from Jones River at Kingston.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1887.												
1061	Oct. 27	Oct. 28	Very slight.	Sl't, brown.	0.45	4.80	1.70	3.10	.0004	.0167	.70	.0030	–

Odor, mouldy. —— The sample was collected from the river near the pumping station of the Kingston Water Works.

Lakeville.

Chemical Examination of Water from Assawompsett Pond in Lakeville.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
97	June 14	June 15	Decided.	Heavy, brown.	0.80	4.32	2.25	2.07	.0002	.0206	–	.0000	–
703	Sept. 7	Sept. 8	Distinct.	Slight.	0.10	2.95	0.90	2.05	.0009	.0154	.48	.0030	–
	1888.												
1594	Jan. 15	Jan. 16	Slight.	Slight, white.	0.20	3.55	1.30	2.25	.0002	.0268	.46	.0050	.0000
2490	May 23	May 24	Slight.	Slight, brown.	0.40	4.85	1.40	3.45	.0000	.0208	.44	.0010	.0001
Av.	....	....	....	....	0.38	3.92	1.46	2.46	.0003	.0209	.46	.0023	–

Hardness in May, 1888, 1.0. Odor, faintly vegetable.—— Sample No. 97 was collected near the shore of the pond five feet beneath the surface. A strong wind was blowing at the time the sample was collected. Sample No. 703 was collected about 4,000 feet from the shore and from seven to ten feet beneath the surface. The remaining samples were collected near the shore of the pond.

Microscopical Examination.

May, 1888. 1. Blue-green algæ, 0.0; 2. Other algæ, pr.; 3. Fungi, 0.0; 4. Animal forms, pr.

Groups and principal genera of organisms observed: 2. Desmidiaceæ; Diatomaceæ. 4. Spongiaria; Entomostraca.

Chemical Examination of Water from Little Quittacas Pond in Lakeville.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
96	June 14	June 15	Slight.	Slight.	0.30	2.87	1.45	1.42	.0000	.0129	.55	.0000	–
691	Sept. 5	Sept. 6	Slight.	Slight.	0.15	2.97	0.87	2.10	.0007	.0170	.48	.0070	–
	1888.												
1705	Jan. 30	Jan. 31	Very slight.	Slight, white.	0.10	3.25	1.30	1.95	.0000	.0178	.54	.0070	.0000
2535	May 29	May 31	Slight.	Very slight.	0.20	2.75	1.00	1.75	.0006	.0164	.43	.0000	.0001
Av.	....	....	....	....	0.19	2.96	1.15	1.81	.0003	.0160	.50	.0035	–

Hardness in May, 1888, 0.8. Odor, faintly vegetable.——The samples were collected from near the middle of the pond five feet beneath the surface.

Microscopical Examination.

May, 1888. 1. Blue-green algæ, 0.0; 2. Other algæ, pr.; 3. Fungi, 0.0; 4. Animal forms, 0.0.
Groups and principal genera of organisms observed: 2. Palmellaceæ; Desmidiaceæ; Diatomaceæ.

Chemical Examination of Water from Elder's Pond in Lakeville.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
702	Sept. 7	Sept. 8	Slight.	Sl't, brown.	0.00	2.50	0.58	1.92	.0004	.0130	.41	.0030	-
	1888.												
2523	May 28	May 29	Slight.	Very slight.	0.05	2.00	0.45	1.55	.0000	.0138	.35	.0000	.0000

Hardness in May, 1888, 0.6. Odor, faintly vegetable.——Sample No. 702 was collected from the pond about 500 feet from the east shore. Sample No. 2523 was collected from the pond close to the shore.

Microscopical Examination.

May, 1888. 1. Blue-green algæ, 0.0; 2. Other algæ, pr.; 3. Fungi, 0.0; 4. Animal forms, pr.
Groups and principal genera of organisms observed: 2. Palmellaceæ; Diatomaceæ. 4. Protozoa.

Water Supply of Lancaster. — Lancaster Water Company.

Description of Works. — Population in 1885, 2,050. The Lancaster Water Company owns the distributing system in the town and purchases water from the town of Clinton. Water was introduced in 1885. *See Clinton.*

Water Supply of Lawrence.

Description of Works. — Population in 1885, 38,862. The works are owned by the city. Water was introduced in 1875. The average daily consumption in 1888 was 2,677,000 gallons. The source of supply is the Merrimack River above the city, where its waters are ponded by the dam of the Essex Company. Water is taken from the river directly, and is also taken from a filter-gallery near the river; the amount coming from the gallery, however, is but a small proportion of the whole. The Merrimack River above the Essex Company's dam has a watershed of 4,634 square miles, containing in 1885 a population of 362,803, equal to

78.3 persons per square mile. The cities and towns on the watershed having a population of more than 10,000 are as follows: —

City or Town.	Population.
Lowell, Mass. (1885),	64,107
Manchester, N. H. (1880),	32,630
Concord, N. H. (1880),	13,843
Nashua, N. H. (1880),	13,397
Fitchburg, Mass. (1885),	12,429
Marlborough, Mass. (1885),	10,127
Total,	146,533

Lowell is situated on the Merrimack River 9 miles above the intake of the Lawrence Water Works, and is provided with sewers which discharge directly into the river. The large manufacturing establishments in this city also turn their wastes into the stream. All of the other cities mentioned are at a greater distance from Lawrence.

A more complete description of the Merrimack valley and the conditions affecting the purity of the water of the river will be found subsequently in the chapter relating to "Rivers."

The filter-gallery is 300 feet long, 8 feet wide and 8 feet high. Its bottom is 15 feet below the crest of the Essex Company's dam. The sides of the gallery are of rubble masonry and the roof is a brick arch. Water enters the gallery at the bottom, which is covered with a layer of broken stones. Water flows by gravity from the river or filter-gallery or both, to the pump well from which it is lifted to an open distributing reservoir. The reservoir is rectangular in shape, 694 feet long, 375 feet wide, and 25 feet deep at high-water mark. Its capacity is 40,000,000 gallons, equal to 15 days' supply at the rate of consumption in 1888. It is separated into two equal compartments by a division embankment having its top three feet below high-water mark.

The force main runs through this embankment to the middle of the reservoir, where it turns upward and discharges upon a stone platform from which the water falls over six granite steps into either or both compartments of the reservoir. The object of this arrangement is to aerate the water. Water is distributed through cast-iron mains. Rubber-lined iron was first adopted for service pipes, then galvanized iron, and more recently lead. Most of the service pipes

in use at the present time are of galvanized iron. Water is supplied from the Lawrence Water Works to a portion of the town of Methuen.

Chemical Examination of Water from the Merrimack River at the Intake of the Lawrence Water Works, collected One Foot beneath the Surface.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
108	June 15	June 16	Slight, milky.	Consid'ble, brown.	0.40	4.02	1.75	2.27	.0009	.0207	.17	.0130	-
345	July 15	July 16	Distinct.	Slight.	0.40	4.40	1.00	3.40	.0027	.0170	.19	.0070	-
582	Aug. 19	Aug. 20	Decided.	Considerable, earthy.	0.55	6.25	1.42	4.83	.0059	.0275	.21	.0130	-
798	Sept. 16	Sept. 17	Slight.	Slight.	0.30	4.65	1.00	3.65	.0017	.0192	.24	.0070	-
1009	Oct. 21	Oct. 22	Slight.	Sl't, earthy and floc't.	0.50	4.95	1.05	3.90	.0034	.0187	.28	.0080	-
1220	Nov. 18	Nov. 19	Distinct.	Con., earthy and floc't.	0.65	4.65	1.20	3.45	.0018	.0234	.24	.0100	-
	1888.												
1648	Jan. 20	Jan. 21	Slight.	Slight, earthy.	0.30	4.30	1.15	3.15	.0022	.0140	.17	.0180	.0001
1859	Feb. 17	Feb. 18	Distinct.	Slight.	0.30	4.15	1.05	3.10	.0051	.0204	.25	.0120	.0001
2026	Mar. 16	Mar. 17	Distinct.	Very slight.	0.20	3.85	1.00	2.85	.0030	.0179	.19	.0100	.0001
2274	Apr. 20	Apr. 21	Distinct.	Con., earthy and fibr'us.	0.25	6.05 2.60	0.65 0.80	5.40 1.80	.0004	.0130	.11	.0090	.0003
2495	May 22	May 24	Decided.	Much, earthy.	-	-	-	-	.0000	.0146	-	-	-
2619	June 15	June 16	Distinct.	Considerable.	0.30	3.60	0.90	2.70	.0028	.0196 .0116	.20	.0080	.0002
2814	July 20	July 23	Slight.	Very slight.	0.15	3.65	0.85	2.80	.0064	.0198 .0156	.18	.0050	.0002
2973	Aug. 17	Aug. 18	Slight.	Slight. earthy.	0.25	3.80	0.90	2.90	.0046	.0190 .0156	.25	.0100	.0002
2975	Aug. 17	Aug. 18	Slight.	Slight, earthy.	0.25	3.85	0.90	2.95	.0036	.0190 .0146	.24	.0100	.0002
2974	Aug. 17	Aug. 18	Slight.	Slight, earthy.	0.25	3.90	0.80	3.10	.0048	.0226 .0154	.23	.0120	.0002
3242	Sept. 21	Sept. 22	Very slight.	Considerable, earthy.	0.15	3.80	1.35	2.45	.0040	.0222 .0180	.17	.0100	.0003
3406	Oct. 19	Oct. 20	Distinct.	Considerable, earthy.	0.70	3.90	1.60	2.30	.0000	.0164 .0148	.14	.0050	.0003
3407	Oct. 19	Oct. 20	Slight.	Slight, earthy.	0.60	3.65	1.45	2.20	.0002	.0186 .0164	.15	.0070	.0002
3565	Nov. 16	Nov. 17	Decided.	Considerable.	0.45	3.20	1.30	1.90	.0000	.0192 .0158	.14	.0050	.0005

Chemical Examination of Water from the Merrimack River at the Intake of the Lawrence Water Works, collected One Foot beneath the Surface — Concluded.

Number	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.		Nitrates.	Nitrites.
	1889.												
3876	Jan. 18	Jan. 19	Distinct.	Con., earthy and floc't.	0.15	2.95	0.90	2.05	.0006	.0138 .0098	.13	.0060	.0003
4089	Feb. 22	Feb. 23	Slight.	Slight.	0.20	3.35	1.05	2.30	.0006	.0126 .0102	.17	.0180	.0004
4380	Mar. 22	Mar. 23	Slight.	Con., light gray.	0.25	3.10	0.75	2.35	.0006	.0124 .0100	.11	.0040	.0006
4543	Apr. 19	Apr. 20	Slight.	Con., earthy and floc't.	0.25	2.70	0.75	1.95	.0008	.0152 .0122	.12	.0050	.0003
4687	May 17	May 18	Distinct.	Con., earthy and floc't.	0.30	3.35	0.90	2.45	.0030	.0164 .0146	.18	.0060	.0004
Av.	....	....	....	....	0.33	4.73	1.13	3.60	.0023	.0180	.18	.0091	.0003

NOTE. — In making the above average, the mean analysis has been used where more than one analysis is given for any day.

Hardness in May, 1888, 1.1. Odor, very faintly vegetable, often none, occasionally mouldy. —— The samples were collected from the river over the end of the intake pipe of the Lawrence Water Works, one foot beneath the surface, until August, 1888. After that time they were generally collected from the middle of the river opposite the intake. No. 2973 was collected about one foot beneath the surface, half way between the north bank and the middle of the river. No. 2975 was collected from the middle of the river. No. 2974 was collected midway between the middle of the river and the south bank. No. 3242 was collected from the middle of the south half of the river. Nos. 3406 and 3407 were from the north and south halves of the river respectively. For volumes of water flowing in the river at times when samples of water were collected for analysis, see page 183.

Microscopical Examination.

	1888.									1889.				
	June.	July.	Aug.	Aug.	Aug.	Sept.	Oct.	Oct.	Nov.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ, .	pr.	0.0	0.0	pr.	pr.	0.0	0.0	0.0	0.0	0.0	0.0	pr.	0.0	0.0
2. Other Algæ, . .	5.4	4.5	4.8	3.2	5.0	0.8	0.1	0.2	pr.	0.9	0.3	1.3	1.7	0.5
3. Fungi, ...	2.0	3.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	pr.	0.0	0.0
4. Animal Forms, . .	0.1	pr.	0.2	0.4	pr.	pr.	0.0	0.0	0.0	0.0	0.0	0.2	pr.	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ, *Chlorococcus;* Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Synedra*, *Tabellaria.* 3. Schizomycetes, *Crenothrix*, *Leptothrix.* 4. Protozoa; Rotifera.

Chemical Examination of Water from the Merrimack River at the Intake of the Lawrence Water Works, collected Six Feet or more beneath the Surface.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.		Nitrates.	Nitrites.
	1887.												
107	June 15	June 16	Slight, milky.	Consid'ble, brown.	0.40	4.80	1.77	3.03	.0004	.0170	.17	.0060	–
347	July 15	July 16	Slight.	Consid'ble, brown.	0.40	4.80	1.00	3.80	.0025	.0177	.15	.0070	–
583	Aug. 19	Aug. 20	Decided.	Consid'ble, earthy.	0.55	6.55	1.37	5.18	.0034	.0258	.21	.0130	–
799	Sept. 16	Sept. 17	Slight.	Slight.	0.30	4.75	0.90	3.85	.0012	.0194	.27	.0260	–
1010	Oct. 21	Oct. 22	Very slight.	Sli't, earthy and floc't.	0.50	4.65	0.65	4.00	.0038	.0210	.27	.0100	–
1221	Nov. 18	Nov. 19	Decided.	Con., e'rthy and floc't.	0.65	4.85	1.25	3.60	.0018	.0217	.23	.0100	–
	1888.												
1649	Jan. 20	Jan 21	Slight.	Very slight.	0.25	4.05	1.05	3.00	.0018	.0142	.16	.0180	.0001
1860	Feb. 17	Feb. 18	Slight.	Very slight.	0.30	4.15	1.10	3.05	.0042	.0184	.22	.0150	.0001
2027	Mar. 16	Mar. 17	Distinct.	Very slight.	0.25	3.90	1.05	2.85	.0029	.0174	.20	.0150	.0002
2275	Apr. 20	Apr. 21	Distinct.	Much, e'rthy and fibr'us.	0.25	7.15 2.55	0.80 0.85	6.35 1.70	.0003	.0134	.10	.0100	.0003
2494	May 22	May 24	Decided.	Much, e'rthy and fibr'us.	–	–	–	–	.0004	.0150	–	–	–
2620	June 15	June 16	Distinct.	Consid'ble.	0.50	3.50	1.10	2.40	.0036	.0180 .0154	.20	.0080	.0002
2815	July 20	July 23	Slight.	Sli't, earthy and floc't.	0.15	3.65	0.70	2.95	.0078	.0204 .0150	.21	.0050	.0002
Av.	....	....	....	....	0.38	4.96	1.09	3.87	.0026	.0184	.20	.0119	.0002

Hardness in May, 1888, 1.1. Odor, very faintly vegetable, occasionally mouldy.——The samples were collected from the river six feet beneath the surface, with the exception of Nos. 2494 and 2620, which were collected at eight feet beneath the surface, and No. 2275, which was collected at ten feet beneath the surface. For volumes of water flowing in the river at times when samples of water were collected for analysis, see page 183.

Microscopical Examination.

	1888.				
	March.	April.	May.	June.	July.
1. Blue-green Algæ, ...	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	pr.	pr.	pr.	1.2	9.3
3. Fungi, ...	0.0	0.0	0.0	1.0	1.0
4. Animal Forms, ...	0.0	0.0	0.0	0.0	0.1

Groups and principal genera of organisms observed: 2. Palmellaceæ, *Chlorococcus;* Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Synedra*. 3. Schizomycetes, *Crenothrix*, *Leptothrix*. 4. Protozoa.

Chemical Examination of Water from the Force Main at the Pumping Station of the Lawrence Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
110	June 15	June 16	Sl't, milky.	Con.,brown.	0.30	4.65	1.95	2.70	.0010	.0154	.17	.0190	–
348	July 15	July 16	Slight.	Con.,brown.	0.40	4.75	1.00	3.75	.0022	.0176	.17	.0100	–
584	Aug. 19	Aug. 20	Decided.	Con.,earthy and floc't.	0.55	6.55	1.37	5.18	.0028	.0259	.21	.0130	–
801	Sept. 16	Sept. 17	Decided.	Sl't, earthy.	0.20	4.95	0.90	4.05	.0014	.0193	.25	.0130	–
1012	Oct. 21	Oct. 22	Slight.	Sl't, earthy and floc't.	0.45	6.00	1.30	4.70	.0026	.0194	.28	.0150	–
1223	Nov. 18	Nov. 19	Distinct.	Sl't, earthy and floc't.	0.65	5.30	1.40	3.90	.0012	.0235	.26	.0100	–
1430	Dec. 15	Dec. 17	Distinct.	Sl't, earthy and floc't.	0.45	6.15	1.45	4.70	.0010	.0232	.20	.0180	–
	1888.												
1651	Jan. 20	Jan. 21	Distinct.	Sl't, earthy and floc't.	0.30	4.35	1.25	3.10	.0022	.0134	.15	.0200	.0001
1862	Feb. 17	Feb. 18	Distinct.	Sl't, white.	0.30	4.20	0.95	3.25	.0045	.0158	.23	.0180	.0001
2028	Mar. 16	Mar. 17	Distinct.	Slight.	0.25	4.30	1.20	3.10	.0030	.0172	.21	.0200	.0002
2276	Apr. 20	Apr. 21	Distinct.	Con.,earthy and floc't.	0.25	7.60 2.80	0.80 0.90	6.80 1.90	.0000	.0125	.14	.0250	.0002
2497	May 22	May 24	Decided.	Sl't, earthy and floc't.	–	–	–	–	.0004	.0144	–	–	–
2816	July 20	July 21	Slight.	Considerable.	0.10	3.85	0.60	3.25	.0052	.0204 .0140	.20	.0170	.0002
2976	Aug. 17	Aug. 18	Slight.	Sl't, earthy and floc't.	0.20	3.80	0.85	2.95	.0064	.0168 .0146	.22	.0150	.0002
3243	Sept. 21	Sept. 22	Slight.	Sl't, earthy and floc't.	0.20	3.80	1.45	2.35	.0036	.0186 .0152	.19	.0100	.0003
3408	Oct. 19	Oct. 20	Distinct.	Sli't, gray.	0.60	3.80	1.30	2.50	.0000	.0154 .0128	.16	.0150	.0003
3566	Nov. 16	Nov. 17	Distinct.	Considerable, gray.	0.45	3.60	1.35	2.25	.0000	.0182 .0148	.15	.0080	.0004
3720	Dec. 14	Dec. 15	Distinct.	Con.,earthy and floc't.	0.15	3.75	1.15	2.60	.0006	.0124 .0086	.21	.0120	.0003
	1889.												
3877	Jan. 18	Jan. 19	Distinct.	Con.,earthy and floc't.	0.15	3.20	1.00	2.20	.0004	.0142 .0110	.17	.0100	.0004
4090	Feb. 22	Feb. 23	Decided.	Slight.	0.20	3.60	1.20	2.40	.0048	.0148 .0102	.21	.0320	.0000
4382	Mar. 22	Mar. 23	Slight.	Con., light gray.	0.20	3.00	0.85	2.15	.0000	.0110 .0092	.14	.0050	.0003
4544	Apr. 19	Apr. 20	Slight.	Con.,earthy and floc't.	0.20	2.75	0.80	1.95	.0006	.0164 .0120	.12	.0080	.0002
4688	May 17	May 18	Distinct.	Con.,earthy and floc't.	0.25	3.55	1.10	2.45	.0024	.0186 .0152	.19	.0030	.0004
Av.	....	....	....	....	0.31	5.35	1.23	4.12	.0020	.0171	.19	.0144	.0002

Hardness in May, 1888, 1.1. Odor, very faintly vegetable, often none, occasionally mouldy.—— The samples were collected from a faucet in the check-valve just beyond the pump, and represent a mixture of water from the river and the filter-gallery, though but a small part of the water comes from the latter source.

Microscopical Examination.

	1888.						1889.				
	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ,	0.0	0.0	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ,	7.9	2.6	0.4	2.7	0.3	0.8	0.6	1.2	2.0	0.2	0.2
3. Fungi,	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms,	pr.	0.1	0.0	0.0	pr.	0.0	0.0	pr.	0.0	0.0	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ, *Chlorococcus, Botryococcus;* Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Synedra, Tabellaria.* 3. Schizomycetes, *Crenothrix.* 4. Protozoa.

Chemical Examination of Water from the Distributing Reservoir of the Lawrence Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
109	June 15	June 16	Sli't, milky.	Slight.	0.30	3.60	1.62	1.98	.0014	.0129	.14	.0190	–
346	July 15	July 16	Very slight.	None.	0.40	3.70	0.90	2.80	.0037	.0150	.13	.0100	–
585	Aug. 19	Aug. 20	None.	Very slight.	0.50	4.15	0.82	3.33	.0041	.0183	.14	.0130	–
800	Sept. 16	Sept. 17	Very slight.	Very slight.	0.30	4.25	0.85	3.40	.0029	.0170	.19	.0130	–
1011	Oct. 21	Oct. 22	Very slight.	Sli't, earthy and floc't.	0.45	4.40	0.90	3.50	.0028	.0162	.23	.0150	–
1222	Nov. 18	Nov. 19	Distinct.	Sli't, white.	0.25	4.20	0.80	3.40	.0031	.0179	.27	.0180	–
1429	Dec. 15	Dec. 17	Slight.	Sli't, white.	0.30	4.40	1.10	3.30	.0017	.0162	.24	.0180	–
	1888.												
1650	Jan. 20	Jan. 21	Slight.	Sli't, earthy and floc't.	0.30	3.95	1.05	2.90	.0016	.0132	.16	.0250	.0001
1861	Feb. 17	Feb. 18	Very slight.	Slight.	0.30	4.20	1.10	3.10	.0043	.0162	.24	.0180	.0001
2029	Mar. 16	Mar. 17	Distinct.	Very slight.	0.25	3.80	1.00	2.80	.0029	.0144	.18	.0250	.0001
2277	Apr. 20	Apr. 21	Slight.	Sli't, earthy and floc't.	0.25	3.00	0.75	2.25	.0018	.0118	.15	.0200	.0002
2496	May 22	May 24	Distinct.	Con., earthy and floc't.	–	–	–	–	.0000	.0148	–	–	–
2817	July 20	July 21	Slight.	Very slight.	0.15	3.75	0.90	2.85	.0046	.0142 .0132	.20	.0170	.0002
2977	Aug. 17	Aug. 18	Very slight.	Very slight.	0.15	4.25	1.20	3.05	.0088	.0134 .0126	.22	.0090	.0002
3244	Sept. 21	Sept. 22	Very slight.	Slight.	0.10	3.90	1.40	2.50	.0074	.0144 .0132	.23	.0180	.0003
3409	Oct. 19	Oct. 20	Very slight.	Very slight.	0.70	3.95	1.65	2.30	.0004	.0150 .0136	.14	.0120	.0002
3567	Nov. 16	Nov. 17	Very slight.	Slight.	0.30	3.65	1.40	2.25	.0002	.0152 .0146	.17	.0080	.0005
3721	Dec. 14	Dec. 15	Slight.	Considerable.	0.20	3.65	1.40	2.25	.0004	.0122 .0104	.19	.0150	.0003

Chemical Examination of Water from the Distributing Reservoir of the Lawrence Water Works — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
3878	Jan. 18	Jan. 19	Slight.	Slight.	0.15	3.20	0.95	2.25	.0002	.0106 .0094	.17	.0090	.0003
4091	Feb. 22	Feb. 23	Very slight.	Slight.	0.20	3.45	0.90	2.55	.0004	.0100 .0076	.17	.0200	.0004
4381	Mar. 22	Mar. 23	Very slight.	Slight.	0.20	3.20	0.90	2.30	.0016	.0116 .0102	.15	.0090	.0006
4545	Apr. 19	Apr. 20	Very slight.	Con., earthy and floc't.	0.20	2.90	0.85	2.05	.0014	.0130 .0114	.14	.0090	.0003
4686	May 17	May 18	Slight.	Very slight.	0.15	3.15	1.05	2.10	.0016	.0142 .0120	.15	.0130	.0003
Av.	....	....	....	....	0.28	3.97	0.99	2.98	.0025	.0142	.18	.0151	.0003

Hardness in May, 1888, 1.0. Odor, very faintly vegetable, often none, occasionally mouldy. —— The samples were collected from a faucet in the gate-house, and represent water flowing out of the reservoir.

Microscopical Examination.

	1888. July.	1888. Aug.	1888. Sept.	1888. Oct.	1888. Nov.	1888. Dec.	1889. Jan.	1889. Feb.	1889. Mar.	1889. Apr.	1889. May.
1. Blue-green Algæ,	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ,	1.9	3.8	10.1	0.0	0.0	0.2	pr.	0.7	1.1	1.1	0.3
3. Fungi,	0.7	0.0	0.0	0.0	0.0	0.0	0.0	pr.	0.0	0.0	0.0
4. Animal Forms,	0.0	pr.	0.0	0.0	0.0	0.0	pr.	pr.	0.1	pr.	pr.

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ, *Chlorococcus;* Zoosporeæ; Diatomaceæ; Zygnemaceæ. 3. Schizomycetes. 4. Protozoa; Spongiaria; Entomostraca.

Chemical Examination of Water from a Faucet at the Experimental Station of the State Board of Health at Lawrence.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
–	Jan. 2	Jan. 3	–	–	–	4.40	1.40	3.00	.0034	.0152	.17	.0050	.0000
–	Jan. 4	Jan. 5	–	–	–	4.10	1.30	2.80	.0030	.0132	.19	.0070	.0000
–	Jan. 6	Jan. 7	–	–	–	4.00	1.30	2.70	.0016	.0140	.21	.0100	.0000
–	Jan. 9	Jan. 10	–	–	–	3.85	1.20	2.65	.0040	.0130	.16	.0250	.0000

Chemical Examination of Water from a Faucet at the Experimental Station of the State Board of Health at Lawrence — Continued.

Number.	Date of Collection.	Date of Exam-ination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albu-minoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
–	Jan. 11	Jan. 12	–	–	–	3.90	1.30	2.60	.0036	.0130	.13	.0250	.0000
–	Jan. 15	Jan. 16	–	–	–	3.80	1.10	2.70	.0022	.0110	.19	.0250	.0000
–	Jan. 19	Jan. 20	–	–	–	3.95	1.30	2.65	.0016	.0092	.12	.0100	.0001
–	Jan. 23	Jan. 24	–	–	–	4.05	1.30	2.75	.0030	.0132	.17	.0090	.0000
–	Jan. 26	Jan. 27	–	–	–	4.20	1.40	2.80	.0022	.0122	.20	.0200	.0000
–	Jan. 30	Jan. 31	–	–	–	4.35	1.20	3.15	.0026	.0114	.15	.0100	.0005
–	Feb. 2	Feb. 3	–	–	–	4.20	1.45	2.75	.0034	.0112	.18	.0250	.0000
–	Feb. 6	Feb. 7	–	–	–	4.25	0.95	3.30	.0036	.0120	.27	.0150	.0000
–	Feb. 9	Feb. 11	–	–	.15	4.20	1.40	2.80	.0036	.0112	.20	.0180	.0000
–	Feb. 13	Feb. 16	–	–	.20	4.05	0.50	3.55	.0030	.0118	.26	.0100	.0000
–	Feb. 16	Feb. 18	–	–	.20	3.75	0.85	2.90	.0032	.0116	.26	.0050	.0000
–	Feb. 23	Feb. 25	–	–	.20	4.05	1.35	2.70	.0038	.0116	.22	.0100	.0000
–	Mar. 1	Mar. 2	Slight.	Slight, brown, floc.	.35	4.20	1.20	3.00	.0044	.0098	.20	.0200	–
–	Mar. 8	Mar. 9	Slight.	Slight, brown, floc.	–	3.50	1.20	2.30	.0032	.0114	.19	.0250	.0000
–	Mar. 15	Mar. 16	Slight.	Slight, brown, floc.	.30	4.90	1.70	3.20	.0028	.0082	.18	.0200	.0000
–	Mar. 22	Mar. 23	Slight.	Very slight.	.30	3.75	1.00	2.75	.0032	.0130	.23	.0200	–
–	Mar. 29	Mar. 30	Slight.	Slight, brown, floc.	.35	3.80	1.05	2.75	.0032	.0114	.21	.0180	.0002
–	Apr. 5	Apr. 6	Slight.	Slight, brown, floc.	.30	3.15	0.95	2.20	.0018	.0102	.25	.0100	–
–	Apr. 12	Apr. 13	Distinct.	Slight.	.20	3.05	0.70	2.35	.0016	.0124	.16	.0100	.0002
–	Apr. 19	Apr. 20	Distinct.	Slight, brown, floc.	.20	3.10	0.75	2.35	.0026	.0108	.18	.0180	.0002
–	Apr. 26	Apr. 27	Distinct.	Consid'ble, brown, floc.	.30	4.05	0.90	3.15	.0014	.0102	.15	.0250	.0002
–	May 10	May 11	Distinct.	Slight.	.10	3.40	1.00	2.40	.0008	.0082	.12	.0180	.0001
–	May 17	May 19	Distinct.	Slight.	.10	3.50	1.30	2.20	.0002	.0112	.12	.0180	.0003
–	May 24	May 25	Decided.	Consid'ble.	.30	3.65	1.50	2.15	.0008	.0094	.12	.0150	.0003
–	June 5	June 6	Very slight.	Very slight.	.30	3.90	0.80	3.10	.0008	.0092	.13	.0150	.0001
–	June 12	June 13	Very slight.	Very slight.	.30	3.40	1.44	1.96	.0004	.0090	.18	.0120	.0000
–	June 19	June 20	Slight.	Slight.	.20	3.24	1.00	2.24	.0008	.0094	.21	.0120	.0000
–	June 26	June 27	Very slight.	Very slight.	.20	3.68	1.12	2.56	.0006	.0104	.19	.0180	.0000
–	July 3	July 5	Very slight.	Very slight.	–	4.00	0.96	3.04	.0024	.0100	.24	.0200	.0000
–	July 10	July 11	Very slight.	None.	.10	4.00	0.80	3.20	.0064	.0126	.22	.0150	.0006
–	July 17	July 18	None.	Slight.	.10	4.08	1.08	3.00	.0004	.0114	.26	.0230	.0000
–	July 24	July 25	None.	None.	.25	3.72	0.76	2.96	.0006	.0100	.36	.0300	.0000

Chemical Examination of Water from a Faucet at the Experimental Station of the State Board of Health at Lawrence — Continued.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
–	July 31	Aug. 1	Very slight.	Very slight.	.10	3.84	1.04	2.80	.0012	.0120	.23	.0220	.0000
–	Aug. 7	Aug. 8	Very slight.	Very slight.	.10	4.60	2.40	2.20	.0000	.0120	.33	.0230	.0000
–	Aug. 14	Aug. 15	Very slight.	Very slight.	.10	4.04	1.16	2.88	.0010	.0096	.29	.0250	.0000
–	Aug. 21	Aug. 22	Very slight.	Very slight.	.05	4.44	2.64	1.80	.0010	.0116	.29	.0200	.0000
–	Aug. 28	Aug. 29	Very slight.	Very slight.	.10	4.16	1.56	2.60	.0008	.0116	.24	.0220	.0000
–	Sept. 4	Sept. 5	Very slight.	None.	.05	5.08	2.32	2.76	.0002	.0100	.25	.0220	.0000
–	Sept. 6	Sept. 7	Very slight.	Very slight.	.15	4.12	0.52	3.60	.0026	.0144	.25	.0230	.0000
–	Sept. 11	Sept. 12	None.	None.	.10	4.24	1.40	2.84	.0012	.0116	.26	.0220	.0000
–	Sept. 18	Sept. 19	Very slight.	Very slight.	.05	4.48	1.44	3.04	.0006	.0112	.24	.0240	.0000
–	Sept. 25	Sept. 26	Very slight.	None.	.10	4.28	1.04	3.24	.0016	.0118	.24	.0230	.0000
–	Oct. 2	Oct. 3	Very slight.	None.	.40	4.04	1.44	2.60	.0014	.0124	.22	.0220	.0000
–	Oct. 9	Oct. 10	Very slight.	None.	.30	4.28	1.68	2.60	.0006	.0180	.20	.0240	.0000
–	Oct. 16	Oct. 17	Very slight.	None.	.40	4.12	1.60	2.52	.0006	.0134	.22	.0220	.0000
–	Oct. 23	Oct. 24	Very slight.	Very slight.	.50	3.78	1.22	2.56	.0022	.0144	.24	.0220	.0000
–	Oct. 30	Oct. 31	Very slight.	Very slight.	.60	3.52	1.32	2.20	.0012	.0140	.20	.0200	.0000
–	Nov. 6	Nov. 7	Very slight.	Very slight.	.50	4.32	1.16	3.16	.0006	.0118	.24	.0240	.0000
–	Nov. 13	Nov. 14	Very slight.	None.	.40	4.20	1.08	3.12	.0008	.0134	.23	.0240	.0000
–	Nov. 20	Nov. 21	Very slight.	Very slight.	.40	3.84	1.36	2.48	.0004	.0100	.24	.0210	.0000
–	Nov. 27	Nov. 28	Very slight.	Very slight.	.40	4.12	1.56	2.56	.0004	.0102	.26	.0200	.0000
–	Dec. 4	Dec. 5	Very slight.	Very slight.	.30	4.04	1.12	2.92	.0004	.0086	.26	.0220	.0000
–	Dec. 11	Dec. 12	Very slight.	Very slight.	.20	3.88	1.20	2.68	.0006	.0098	.24	.0250	.0000
–	Dec. 18	Dec. 19	Very slight.	Very slight.	.25	3.82	1.04	2.78	.0010	.0076	.21	.0330	.0000
–	Dec. 24	Dec. 26	Distinct.	Very slight.	.25	3.88	0.88	3.00	.0014	.0108	.20	.0240	.0000
	1889.												
–	Jan. 1	Jan. 1	Slight.	Very slight.	.30	3.64	0.96	2.68	.0004	.0124	.23	.0300	.0000
–	Jan. 8	Jan. 8	Very slight.	Very slight.	.30	4.25	1.00	3.25	.0006	.0078	.25	.0320	.0000
–	Jan. 15	Jan. 15	Very slight.	Very slight.	.25	3.64	1.08	2.56	.0000	.0096	.21	.0220	.0000
–	Jan. 22	Jan. 22	Very slight.	Very slight.	.30	3.76	1.28	2.48	.0002	.0094	.21	.0230	.0000
–	Jan. 29	Jan. 29	Very slight.	Slight.	.20	3.50	0.90	2.60	.0002	.0102	.26	.0230	.0000
–	Feb. 5	Feb. 5	Very slight.	Very slight.	.20	3.88	1.24	2.64	.0014	.0072	.21	.0270	.0000
–	Feb. 12	Feb. 12	Very slight.	None.	.20	3.68	0.72	2.96	.0004	.0094	.25	.0230	.0000
–	Feb. 19	Feb. 19	Slight.	Very slight.	.15	3.60	0.92	2.68	.0006	.0082	.25	.0180	.0000
–	Feb. 26	Feb. 26	Very slight.	Very slight.	.20	3.52	1.16	2.36	.0006	.0086	.24	.0250	.0002
–	Mar. 5	Mar. 5	Very slight.	Very slight.	.15	3.80	0.84	2.96	.0006	.0098	.24	.0250	.0000
–	Mar. 12	Mar. 12	Very slight.	Very slight.	.15	3.68	0.64	3.04	.0022	.0100	.24	.0200	.0000
–	Mar. 19	Mar. 19	Very slight.	Very slight.	.20	3.36	0.48	2.88	.0018	.0078	.21	.0220	.0000

Chemical Examination of Water from a Faucet at the Experimental Station of the State Board of Health at Lawrence — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
-	Mar. 26	Mar. 26	Very slight.	Very slight.	.20	3.16	0.64	2.52	.0004	.0080	.23	.0230	.0000
-	Apr. 2	Apr. 2	Very slight.	Very slight.	.20	3.36	0.72	2.64	.0012	.0094	.17	.0230	.0000
-	Apr. 9	Apr. 9	Very slight.	Very slight.	.13	3.00	0.48	2.52	.0008	.0088	.17	.0180	.0000
-	Apr. 16	Apr. 16	Very slight.	Very slight.	.20	3.40	0.80	2.60	.0010	.0120	.17	.0140	.0001
-	Apr. 23	Apr. 23	Very slight.	Very slight.	.15	3.80	1.12	2.68	.0006	.0088	.16	.0150	.0000
-	Apr. 30	Apr. 30	Very slight.	Very slight.	.25	3.32	1.24	2.08	.0006	.0086	.14	.0160	.0001
-	May 7	May 7	Very slight.	Very slight.	.20	3.32	1.00	2.32	.0004	.0100	.13	.0120	.0000
-	May 14	May 14	Very slight.	Very slight.	.20	3.28	0.84	2.44	.0004	.0094	.14	.0100	.0000
-	May 21	May 21	Very slight.	Very slight.	.20	3.96	1.32	2.64	.0000	.0112	.15	.0120	.0001
-	May 28	May 28	Very slight.	Very slight.	.30	3.52	1.20	2.32	.0008	.0118	.16	.0170	.0000
Av.	....	....	....	....	0.23	3.83	1.14	2.69	.0014	.0107	.21	.0197	-

NOTE. — The average above given was obtained by taking the mean of all the analyses for each month, and averaging these results.

Volume of Water Flowing in the Merrimack River on the Dates when Samples of Water were Collected for Analysis.

Date.	Volume Flowing in the River in Cubic Feet per Second. Rate of Flow during 11 Hours of the Day.	Volume Flowing in the River in Cubic Feet per Second. Rate of Flow during 24 Hours	Date.	Volume Flowing in the River in Cubic Feet per Second. Rate of Flow during 11 Hours of the Day.	Volume Flowing in the River in Cubic Feet per Second. Rate of Flow during 24 Hours.
1887.			**1888.** — Con.		
June 15,	5,600	4,700	June 15,	6,170	5,270
July 15,	5,830	4,940	July 20,	3,500	2,450
August 19,	12,240	9,830	August 17,	5,000	4,000
September 16,	6,590	5,700	September 21,	10,920	9,970
October 21,	4,050	2,650	October 19,	14,670	13,810
November 18,	9,650	8,740	November 16,	15,520	14,510
December 15,	11,490	10,720	December 14,	9,520	8,660
1888.			**1889.**		
January 20,	13,050	12,110	January 18,	18,050	17,280
February 17,	10,000	9,180	February 22,	8,470	7,630
March 16,	7,740	6,950	March 22,	14,500	13,650
April 20,	25,890	25,100	April 19,	11,740	10,870
May 22,	16,050	15,420	May 17,	6,580	5,750

WATER SUPPLY OF LEE. — BERKSHIRE WATER COMPANY.

Description of Works. — Population in 1885, 4,274. The works are owned by the Berkshire Water Company, and were built in 1881. The source of supply is Codding Brook, on which a storage and a distributing reservoir are built.

The storage reservoir is situated among the mountains east of the Housatonic River, and is said to be at an elevation of 800 feet above the distributing reservoir. It was formed by building a low dam across the valley of the brook at a point where the brook flowed from a tract of meadow land. Its area is 22 acres ; maximum depth, 8 feet ; bottom, muddy ; capacity, 20,000,000 gallons. None of the vegetable growth was removed from the meadow before it was flowed.

The distributing reservoir is situated one mile down stream from the storage reservoir, and is formed like the latter by a dam across the brook. The distributing reservoir has a capacity of 1,500,000 gallons, and its maximum depth is 20 feet. The drainage area is mountainous. Water is distributed by gravity. Distributing mains are of cement-lined wrought iron. Service pipes are of galvanized iron.

Chemical Examination of Water from a Faucet in the Village of Lee supplied from the Lee Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
49	June 6	June 8	None.	None.	0.10	5.62	1.20	4.42	.0001	.0085	.03	.0070	–
251	July 5	July 6	None.	None.	0.04	7.20	1.15	6.05	.0016	.0101	.12	.0130	–
474	Aug. 3	Aug. 4	Slight.	None.	0.80	4.47	1.80	2.67	.0002	.0188	.04	.0070	–
698	Sept. 6	Sept. 7	None.	None.	0.10	5.17	0.62	4.55	.0002	.0057	.09	.0070	–
903	Oct. 6	Oct. 8	None.	None.	0.20	5.50	1.15	4.35	–	.0080	.10	.0050	–
1109	Nov. 4	Nov. 5	None.	None.	0.10	5.30	0.80	4.50	.0000	.0069	.12	.0080	–
1336	Dec. 6	Dec. 7	None.	None.	0.30	3.25	1.20	2.05	.0000	.0098	.09	.0080	–
	1888.												
1533	Jan. 3	Jan. 5	Very slight.	Very slight.	0.20	2.95	0.85	2.10	.0008	.0096	.04	.0030	.0000
1742	Feb. 3	Feb. 4	None.	None.	0.10	3.70	0.70	3.00	.0002	.0052	.05	.0050	.0000
1948	Mar. 5	Mar. 6	None.	None.	0.10	3.35	0.75	2.60	.0000	.0066	.11	.0090	.0000
2154	Apr. 3	Apr. 4	Very slight.	None.	0.10	2.15	0.45	1.70	.0000	.0084	.10	.0100	.0000
2350	May 3	May 4	Slight.	Very slight.	0.10	2.45	0.80	1.65	.0000	.0070	.09	.0080	.0000
Av.	....	....	....	....	0.19	4.26	0.96	3.30	.0003	.0087	.08	.0075	.0000

Hardness in June, 1887, 3.7; in May, 1888, 1.9. Odor, generally none, seldom faintly vegetable.

Microscopical Examination.

April, 1888. 1. Blue-green algæ, 0.0.; 2. Other algæ, pr.; 3. Fungi, 0.0; 4. Animal forms, 0.0.
May, 1888. 1. Blue-green algæ, 0.0; 2. Other algæ, pr.; 3. Fungi, pr.; 4. Animal forms, pr.
Groups and principal genera of organisms observed: 2. Diatomaceæ. 3. Schizomycetes. 4. Protozoa.

Proposed Water Supply of Leicester.

Chemical Examination of Water from a Spring at the head of Kettle Brook in Paxton.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1888.												
2738	July 6	July 9	None.	None.	0.0	3.65	–	–	.0000	.0010	.18	.0500	.0000

Odor, very faint or none.—— The sample was collected from the spring.

Microscopical Examination.

July, 1888. 1. Blue-green algæ, 0.0; 2. Other algæ, 0.2; 3. Fungi, pr.; 4. Animal forms, 0.0.
Groups and principal genera of organisms observed: 2. Zoosporeæ; Diatomaceæ. 3. Schizomycetes.

Water Supply of Lenox.—Lenox Water Company.

Description of Works.—Population in 1885, 2,154. The works are owned by the Lenox Water Company, and were built in 1875. About 1,500 people were supplied in 1887. The sources of supply are three small reservoirs in the mountains west of the village. One of these reservoirs is at the head of the Yoken River, a small stream which flows around Lenox to the north, and empties into the Housatonic River. This reservoir, when full, is said to contain 40,000 gallons. Its drainage area is small, and the slopes are steep and covered with wood. From this reservoir water flows by gravity to the distributing reservoir. The latter reservoir has a capacity of 165,000 gallons and a very small drainage area. The third reservoir is at the head of a small brook which flows into the Williams River. This reservoir has a capacity of 500,000 gallons, and its drainage area of about 360 acres is similar to that of the reservoir on the Yoken River, but is considerably larger. Water is pumped from this reservoir over the dividing ridge to the reservoir on the Yoken River, a distance of a little over a mile. The total drainage area of the three reservoirs is about three-quarters of a square mile, as estimated from the new topographical map of Massachusetts. Distributing mains are of cast iron and service pipes of wrought iron.

Chemical Examination of Water from a Faucet in the Village of Lenox supplied from the Distributing Reservoir.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
47	June 6	June 8	None.	Very slight.	0.0	5.55	0.70	4.85	.0002	.0039	.07	.0000	–
264	July 6	July 7	Decided, milky.	Slight, rusty.	0.0	6.45	0.40	6.05	.0004	.0044	.08	.0070	–
489	Aug. 4	Aug. 6	Slight.	Slight, brown.	0.0	6.60	0.47	6.13	.0000	.0026	.08	.0030	–
730	Sept. 10	Sept. 12	Distinct.	Considerable, earthy.	0.0	6.20	0.27	5.93	.0002	.0027	.06	.0050	–
905	Oct. 7	Oct. 8	Very slight.	Slight, earthy.	0.0	6.85	0.60	6.25	.0000	.0034	.05	.0000	–
1105	Nov. 3	Nov. 4	None.	Very slight.	0.0	6.00	0.25	5.75	.0000	.0008	.04	.0020	–
1433	Dec. 16	Dec. 17	Slight.	Sl't, earthy and floc't.	0.0	5.30	0.45	4.85	.0000	.0038	.06	.0030	–
	1888.												
1532	Jan. 4	Jan. 5	Very slight.	Sl't, earthy and floc't.	0.0	4.90	0.15	4.75	.0000	.0028	.06	.0050	.0001
1737	Feb. 2	Feb. 3	None.	None.	0.0	5.70	0.30	5.40	.0000	.0016	.08	.0060	.0001
1950	Mar. 5	Mar. 6	Slight.	Slight, earthy.	0.0	4.85	0.20	4.65	.0000	.0020	.09	.0060	.0001
2153	Apr. 3	Apr. 4	Very slight.	Sl't, earthy and floc't.	0.0	4.50	0.35	4.15	.0000	.0044	.05	.0080	.0001
2351	May 3	May 4	Very slight.	None.	0.0	4.50	0.10	4.40	.0000	.0010	.06	.0080	.0001
Av.	....	....	....	....	0.0	5.62	0.35	5.27	.0001	.0028	.07	.0044	.0001

Hardness in May, 1888, 3.4. Odor, none. —— There were heavy rains just previous to the collection of Nos. 489 and 730.

Microscopical Examination.

April, 1888. 1. Blue-green algæ, 0.0; 2. Other algæ, pr.; 3. Fungi, 0.0; 4. Animal forms, pr.

May, 1888. 1. Blue-green algæ, 0.0; 2. Other algæ, pr.; 3. Fungi, 0.0; 4. Animal forms, 0.0.

Groups and principal genera of organisms observed: 2. Desmidiaceæ; Diatomaceæ; Zygnemaceæ. 4. Protozoa; Rotifera.

Chemical Examination of Water from Lily Pond, Lenox.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
4021	Feb. 14	Feb. 15	Slight, milky.	Slight, white.	1.0	14.25	1.05	13.20	.0070	.0120 .0082	.20	.0300	.0004

Odor, very faintly vegetable. —— The sample was collected from near the middle of the pond.

WATER SUPPLY OF LEOMINSTER.

Description of Works. — Population in 1885, 5,297. The works are owned by the town and were built in 1873. About 997 service taps were supplied in 1888. The sources of supply are Morse and Haynes brooks, on each of which a storage reservoir is built, and Quarter-of-a-mile Brook, which is formed by the confluence of Morse and Haynes brooks. The Haynes Storage Reservoir is the larger. It was formed by building a dam across Haynes Brook at a point where it flowed from an area of swamp and meadow land. About one-third of the area was a swamp covered with a growth of wood. In preparing the area for flowage, the trees were cut down, but the stumps and vegetable matter were not removed. Its area is 58 acres, and its capacity, when full, 121,000,000 gallons. The maximum depth is 12 feet. The general depth of the reservoir is about 7 feet, and about one-fourth of it is very shallow.

Morse Reservoir was originally built to furnish water power for a mill and was purchased by the town. Its area is 11 acres and its capacity is about 7,000,000 gallons. It has a sandy bottom and there is no shallow flowage.

Morse and Haynes brooks unite, after flowing a short distance below the distributing reservoirs, and form Quarter-of-a-mile Brook. On this brook a small reservoir is built, which is used as a distributing reservoir. Its area is 4½ acres and its capacity 6,750,000 gallons. Water from the storage reservoirs flows down the natural channels of the brooks to the distributing reservoir.

The area of the watershed of Haynes Reservoir is 315 acres, that of Morse Reservoir is 165 acres, and that of the distributing reservoir, excluding the others, is 737 acres; making a total watershed at the outlet of the distributing reservoir of 1,217 acres. These areas are uninhabited, excepting by a very small farming population, and are generally steep, rocky and well wooded, and contain but little cultivated land. The watershed of Haynes Reservoir is chiefly pasture land and there is a small swamp near the reservoir.

Distributing mains and service pipes are of wrought iron lined with cement. For all extensions to distributing mains cast iron is now used.

For two months or more in the autumn of 1882 the water supplied to consumers had a very disagreeable odor and taste. After the first heavy frost the trouble disappeared, but it re-appeared the next season, and as a remedy a filter dam was built in 1884 across the brook just before it enters the distributing reservoir. The filter

dam consists of a rough stone wall built across the upper end of the reservoir, behind which the filtering material is placed. The material consists of cobblestones at the bottom, upon which is a layer of coarse gravel with a layer of fine gravel at the top. Once a year the basin formed by the filter dam is cleaned and the layer of fine gravel over the top of the filter is renewed. Most of the water which enters the distributing reservoir passes through the filter dam, excepting at times of very high water. There is said to have been no serious trouble with the water delivered in the town since that time.

Chemical Examination of Water from Haynes Reservoir, Leominster.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
190	June 24	June 25	Decided.	Slight.	0.40	3.62	2.00	1.62	.0195	.0556	–	–	–
414	July 26	July 28	Very decided.	Slight.	0.80	–	–	–	.0004	.1008	.16	.0000	–
615	Aug. 25	Aug. 26	Decided.	Sli't, green.	0.60	5.15	3.25	1.90	.0006	.1252	.11	.0000	–
1030	Oct. 25	Oct. 26	Distinct.	Sli't, earthy and floc.	0.70	3.15	1.65	1.50	.0010	.0458	.12	.0150	–
1275	Nov. 29	Nov. 30	Very slight.	Slight.	0.45	3.10	1.55	1.55	.0004	.0279	.14	.0150	–
1493	Dec. 27	Dec. 28	Slight.	Slight, white.	0.55	3.05	1.55	1.50	.0019	.0329	.14	.0120	–
	1888.												
1748	Feb. 2	Feb. 4	Slight.	Slight, brown.	0.40	3.65	1.65	2.00	.0130	.0333	.16	.0250	0001
1902	Feb. 27	Feb. 28	Slight.	Very slight.	0.30	2.65	1.00	1.65	.0010	.0230	.13	.0100	.0000
2070	Mar. 20	Mar. 21	Distinct.	Slight.	0.20	2.80	1.25	1.55	.0078	.0268	.12	.0050	.0001
2293	Apr. 23	Apr. 24	Distinct.	Slight.	0.20	2.15	1.05	1.10	.0000	.0216	.12	.0030	.0001
2482	May 21	May 22	Distinct.	Consid'ble, earthy.	0.35	2.40	1.30	1.10	.0000	.0262	.10	.0030	.0000
2652	June 21	June 22	Distinct.	Considerable.	0.45	2.20	1.05	1.15	.0000	.0316 .0200	.10	.0000	.0000
2782	July 16	July 17	Decided.	Con., green.	0.35	3.35	2.25	1.10	.0000	.0526 .0266	.11	.0020	.0000
2991	Aug. 20	Aug. 21	Decided.	Considerable.	0.40	3.65	1.90	1.75	.0024	.0836 .0304	.08	.0070	.0002
3471	Oct. 30	Nov. 1	Slight.	Sli't, green.	0.50	2.65	1.45	1.20	.0010	.0382 .0294	.10	.0070	.0003
3600	Nov. 23	Nov. 24	Distinct.	Very slight.	0.60	3.10	1.60	1.50	.0000	.0304 .0252	.15	.0150	.0002
3790	Dec. 21	Dec. 22	Slight.	Very slight.	0.25	2.15	1.10	1.05	.0000	.0204 .0170	.12	.0050	.0004
	1889.												
3924	Jan. 24	Jan. 25	Distinct.	Very slight.	0.15	2.45	1.05	1.40	.0006	.0210 .0174	.12	.0030	.0002

Chemical Examination of Water from Haynes Reservoir, Leominster — Concluded.

Number.	Date of Collection.	Date of Exam-ination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albu-minoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
4138	Feb. 26	Feb. 27	Distinct.	Slight.	0.15	2.85	1.05	1.80	.0004	.0240 .0158	.13	.0080	.0001
4394	Mar. 25	Mar. 26	Distinct.	Slight.	0.30	2.25	0.85	1.40	.0000	.0228 .0154	.09	.0000	.0001
4552	Apr. 22	Apr. 23	Distinct.	Considerable.	0.15	2.20	0.85	1.35	.0002	.0244 .0162	.08	.0030	.0001
4719	May 22	May 23	Distinct.	Considerable.	0.30	2.00	0.90	1.10	.0004	0308 .0200	.12	.0020	.0002
Av.	....	....	....	....	0.39	3.17	1.63	1.54	.0023	.0409	.12	.0067	.0001

Hardness in May, 1888, 0.2. Odor, vegetable, often disagreeable.——The samples were collected from the reservoir near the gate-house at a depth of about 1 foot beneath the surface, with the exception of No. 2652, which was collected from the reservoir near the upper end.

Microscopical Examination.

	1888. May.	1888. June.	1888. July.	1888. Aug.	1888. Oct.	1888. Nov.	1888. Dec.	1889. Jan.	1889. Feb.	1889. Mar.	1889. Apr.	1889. May.
1. Blue-green Algæ, ...	0.0	0.1	6.0	12.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	pr.	157.4	317.7	27.4	0.2	6.1	0.0	1.1	61.0	9.6	8.6	2.1
3. Fungi, ...	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, ...	0.0	pr.	0.5	0.4	pr.	0.0	0.0	0.7	320.0	1.1	0.2	pr.

Groups and principal genera of organisms observed: 1. Cyanophyceæ, *Anabæna*. 2. Palmellaceæ, *Chlorococcus*, *Protococcus*; Zoosporeæ, *Scenedesmus*, *Staurogenia*; Desmidiaceæ, *Staurastrum*; Diatomaceæ, *Asterionella*, *Melosira*, *Nitzchia*, *Tabellaria*. 3. Schizomycetes. 4. Protozoa, *Dinobryon*, *Peridinium*; Rotifera; Entomostraca.

Chemical Examination of Water from Morse Reservoir, Leominster.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Exam-ination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albu-minoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
191	June 24	June 25	Slight.	Slight.	0.40	2.75	1.00	1.75	.0000	.0154	.11	.0000	–
415	July 26	July 28	None.	Very slight.	0.45	2.62	0.15	2.47	.0038	.0079	.11	.0130	–
616	Aug. 25	Aug. 26	Very slight.	Con., brown.	0.60	3.32	1.72	1.60	.0012	.0215	.08	.0000	–
1031	Oct. 25	Oct. 26	Very slight.	Very slight.	0.10	2.30	0.55	1.75	.0000	.0030	.13	.0000	–
1276	Nov. 29	Nov. 30	Slight.	Very slight.	0.20	2.05	0.45	1.60	.0002	.0104	.15	.0020	–
1494	Dec. 27	Dec. 28	Very slight.	Sli't. earthy and floc't.	0.20	2.40	0.55	1.85	.0010	.0118	.14	.0020	–

Chemical Examination of Water from Morse Reservoir, Leominster — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance: Turbidity.	Appearance: Sediment.	Appearance: Color.	Residue on Evaporation: Total.	Residue on Evaporation: Loss on Ignition.	Residue on Evaporation: Fixed.	Ammonia: Free.	Ammonia: Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
1749	Feb. 2	Feb. 4	Very slight.	Sli't, brown.	0.05	2.50	0.65	1.85	.0007	.0041	.10	.0080	.0000
1903	Feb. 27	Feb. 28	None.	Very slight.	0.25	2.20	0.80	1.40	.0000	.0079	.09	.0020	.0000
2069	Mar. 20	Mar. 21	Very slight.	Very slight.	0.10	1.75	0.40	1.35	.0000	.0048	.12	.0030	.0000
2294	Apr. 23	Apr. 24	Very slight.	Very slight.	0.10	1.50	0.55	0.95	.0000	.0069	.09	.0020	.0001
2481	May 21	May 22	Very slight.	Slight.	0.15	1.95	0.50	1.45	.0000	.0086	.07	.0030	.0000
Av.	....	....	....	....	0.24	2.30	0.67	1.63	.0006	.0093	.11	.0032	–

Hardness in May, 1888, 0.5. Odor, faintly vegetable, sometimes none. —— The samples were collected from Morse Brook just below the reservoir.

Microscopical Examination.

	1888. March.	1888. April.	1888. May.
1. Blue-green Algæ, ...	0.0	0.0	0.0
2. Other Algæ, ...	pr.	pr.	pr.
3. Fungi, ...	0.0	0.0	0.0
4. Animal Forms, ...	0.0	pr.	pr.

Groups and principal genera of organisms observed: 2. Zoosporeæ; Diatomaceæ. 4. Protozoa; Rotifera.

Chemical Examination of Water from the Distributing Reservoir of the Leominster Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance: Turbidity.	Appearance: Sediment.	Appearance: Color.	Residue on Evaporation: Total.	Residue on Evaporation: Loss on Ignition.	Residue on Evaporation: Fixed.	Ammonia: Free.	Ammonia: Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
1032	Oct. 25	Oct. 26	Slight.	Slight, white.	0.30	3.00	1.10	1.90	.0000	.0197	.15	.0000	–
1277	Nov. 29	Nov. 30	Very slight.	Slight.	0.30	2.30	0.85	1.45	.0004	.0126	.17	.0070	–
1492	Dec. 27	Dec. 28	Very slight.	None.	0.40	2.70	1.00	1.70	.0001	.0191	.14	.0090	.0000
	1888.												
3248	Sept. 22	Sept. 22	Distinct.	Slight.	0.35	3.00	1.40	1.60	.0026	.0188 .0150	.08	.0070	.0001
Av.	....	....	....	....	0.45	2.67	0.98	1.60	.0008	.0176	.14	.0058	–

Odor, vegetable or mouldy. —— The samples were collected from the distributing reservoir near the gate-house, with the exception of No. 3248, which was collected from a faucet in the village.

Microscopical Examination.

September, 1888. 1. Blue-green algæ, pr.; 2. Other algæ, 2.3; 3. Fungi, 0.4; 4. Animal forms, pr.

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Diatomaceæ, *Melosira;* Desmidiaceæ. 3. Schizomycetes. 4. Protozoa.

Water Supply of Lexington. — Lexington Water Company.

Description of Works. — Population in 1885, 2,718. The works are owned by the Lexington Water Company. Water was introduced in 1884. The average daily consumption in 1888 was 40,000 gallons. The sources of supply in 1887 and 1888, during the time when analyses of the water were made, were two wells on the border of a meadow. One well is 20 feet in diameter and 29 feet deep, the lower 14 feet being through ledge. The other well is 20 feet in diameter and 18 feet deep. The wells are about 200 feet apart and are connected by a drain pipe laid with open joints covered with about 7 inches of porous material, and above that with muck to the surface. Both wells are built with a brick curbing and are not covered. Pumps force the water to an open iron tank 18 feet in diameter and 35 feet high. Distributing mains are of cast iron and service pipes are nearly all of lead. The remainder are of galvanized iron. Additional wells have recently been connected with the pumps, and a deep tubular well is to be added to the other sources of supply.

Chemical Examination of Water from the Wells of the Lexington Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
80	June 10	June 11	Slight.	None.	0.60	7.50	2.40	5.10	.0008	.0165	.49	.0650	–
303	July 11	July 12	Slight.	Very slight.	0.40	6.45	0.90	5.55	.0012	.0089	.29	–	–
533	Aug. 12	Aug. 12	Very slight, milky.	Very slight.	0.30	8.75	0.90	7.85	.0011	.0069	.40	.0390	–
748	Sept. 13	Sept. 13	Very slight.	Very slight.	0.40	6.55	0.92	5.63	.0007	.0119	.45	.0300	–
933	Oct. 12	Oct. 12	Very slight.	Very slight.	0.45	7.20	1.50	5.70	.0002	.0150	.46	.0390	–
1150	Nov. 10	Nov. 11	Very slight.	None.	0.45	7.90	1.85	6.05	.0000	.0155	.47	.0350	–
1382	Dec. 12	Dec. 13	Very slight.	Very slight.	0.10	8.30	1.20	7.10	.0027	.0079	.40	.0450	–

Chemical Examination of Water from the Wells of the Lexington Water Company — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
1590	Jan. 13	Jan. 14	Slight.	None.	0.30	8.10	2.00	6.10	.0019	.0162	.40	.1200	.0000
1781	Feb. 8	Feb. 9	Very slight.	Sli't, white.	0.40	7.45	2.45	5.00	.0034	.0173	.41	.1000	.0000
1988	Mar. 9	Mar. 10	None.	Very slight, white.	0.40	7.05	1.40	5.65	.0006	.0135	.40	.0900	.0000
2174	Apr. 9	Apr. 10	Slight.	Very slight.	0.90	7.95	2.25	5.70	.0017	.0280	.38	.0800	.0002
2428	May 14	May 15	Very slight.	None.	1.00	8.50	2.90	5.60	.0004	.0240	.39	.0600	.0002
Av.	....	....	....	....	0.48	7.64	1.72	5.92	.0012	.0151	.41	.0647	.0001

Hardness in May, 1888, 3.4. Odor, faintly vegetable or earthy, sometimes none.—— The samples were collected from a faucet on a hydrant at the pumping station.

Microscopical Examination.

April, 1888. 1. Blue-green algæ, 0.0; 2. Other algæ, pr.; 3. Fungi, 0.0; 4. Animal forms, pr.
May, 1888. 1. Blue-green algæ, 0.0; 2. Other algæ, pr.; 3. Fungi, 0.0; 4. Animal forms, 0.0.
Groups and principal genera of organisms observed: 2. Palmellaceæ; Diatomaceæ. 4. Protozoa.

Water Supply of Lincoln.

Description of Works. — Population in 1885, 901. The works are owned by the town and were built in 1874. The source of supply is Sandy Pond in Lincoln. Pumps force the water from the pond to an open distributing reservoir. The bottom of the reservoir is puddled with clay and the slopes are paved. Water enters and is drawn from the reservoir by the same pipe. Distributing mains and service pipes are of wrought iron lined with cement. For a description of the source of supply and analyses of the water, see *Concord*.

Water Supply of Lowell.

Description of Works. — Population in 1885, 64,107. The works are owned by the city. Water was introduced in 1872. The average daily consumption in 1888 was 4,981,000 gallons. The source of supply is the Merrimack River above the city where its waters are ponded by the dam of the Locks and Canals Company. Water is taken from the river directly and is also taken from a filter-gallery and filter-bed along the northern bank of the river in the town of Dracut. The Merrimack River above the Pawtucket

dam at Lowell has a watershed of 4,097 square miles, containing in 1880 a population of 230,266, equal to 56.2 persons per square mile. The cities and towns on the watershed having a population of more than 10,000 are as follows: —

City or Town.	Population.
Manchester, N.H. (1880),	32,630
Concord, N.H. (1880),	13,843
Nashua, N.H. (1880),	13,397
Fitchburg, Mass. (1885),	12,429
Marlborough, Mass. (1885),	10,127
Total,	82,426

The city of Nashua is situated on the Nashua River, at its confluence with the Merrimack River, and is 13 miles above the inlet to the Lowell Water Works.

A more complete description of the Merrimack Valley and the conditions affecting the purity of the water of the river will be found subsequently in the chapter relating to "Rivers."

The filter-gallery is 1,300 feet long, 8 feet wide and 8 feet high, and its top inside is level with the Pawtucket dam. The sides are of rubble masonry and the roof is a brick arch. Water enters the gallery at the bottom, which is covered with a layer of coarse gravel one foot in thickness.

An additional amount of filtered water has at times been obtained from an artificial filter-bed known as the "filter-inlet," located between the filter-gallery and the river. This filter-bed was built in 1876. Its bottom area is 11,400 square feet, and the depth of the filtering material is 7 feet, graded from cobblestones at the bottom to fine sand at the top. A system of under drains collects the filtered water and discharges it into the filter-gallery. The surface of the filter is one foot below the Pawtucket dam. It is divided into two parts, and from the inner and larger part the river water can be kept out except at times of freshets. The surface of the filter becomes clogged in a short time, particularly during freshets, by the deposit of mud and silt upon it; consequently the amount of filtered water obtained from it is small, unless it is cleaned frequently. Under ordinary conditions the filter-gallery and filter-inlet supply but a very small portion of the water used by the city, and under the most favorable conditions the amount supplied is very much less than the consumption.

At the lower end of the filter-gallery, which is 1,500 feet above the Pawtucket bridge, is located the inlet chamber, into which water is drawn from the river or filter-gallery or both. Water is drawn from the river at a point 45 feet from the north bank. From the inlet chamber a brick conduit, 4,183 feet in length, conveys the water to a chamber known as the Bodwell gate-house. From the Bodwell gate-house a 30-inch cast-iron pipe conveys the water by gravity to the pump well at the pumping station, a distance of about 6,656 feet, from which it is lifted by pumps to two distributing reservoirs, one of which is used for low-service distribution and the other for high service.

The low-service distributing reservoir is 520 feet long, 510 feet wide and 20 feet deep at high water. It is shaped like a square with two of its corners cut off. At high-water mark the surface covers an area of 5.2 acres, and its capacity is 30,000,000 gallons. The bottom is of clay puddle one foot in thickness, and the slopes are paved. The water entering the reservoir falls from two to six feet, and the gates are so arranged that water can be drawn from any level.

The high-service distributing reservoir is rectangular in shape, 150 feet long, 130 feet wide and 16 feet deep at high water. Its capacity is 1,324,000 gallons. The bottom is of clay puddle, and the slopes are paved. Water enters the reservoir at the middle and is drawn from it by the same pipe. Distributing mains are of cast iron and service pipes of wrought iron and of lead.

Chemical Examination of Water from the Merrimack River above Lowell opposite the Inlet to the Lowell Water Works.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1887.												
103	June 14	June 15	Slight.	Very slight.	0.40	3.90	1.55	2.35	.0020	.0122	.16	.0130	–
332	July 14	July 15	Very slight.	Slight.	0.40	3.55	1.15	2.40	.0010	.0133	.12	.0030	–
576	Aug. 18	Aug. 19	Very slight.	Very slight.	0.60	4.07	1.15	2.92	.0027	.0177	.14	.0070	–
782	Sept. 15	Sept. 16	Slight.	Slight.	0.15	3.95	0.80	3.15	.0018	.0148	.20	.0070	–
998	Oct. 20	Oct. 21	Very slight.	Very slight.	0.40	3.85	0.70	3.15	.0042	.0152	.19	.0080	–
1209	Nov. 17	Nov. 18	Decided.	Con., earthy and floc't.	0.75	5.15	1.25	3.90	.0026	.0203	.24	.0090	–
1415	Dec. 15	Dec. 16	Decided.	Considerable, earthy.	0.40	5.60	1.50	4.10	.0007	.0169	.15	.0120	–

Chemical Examination of Water from the Merrimack River above Lowell opposite the Inlet to the Lowell Water Works — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
1644	Jan. 19	Jan. 21	Very slight.	Very slight.	0.30	3.95	1.00	2.95	.0016	.0116	.13	.0200	.0001
1848	Feb. 16	Feb. 17	Slight.	Very slight.	0.35	3.90	0.95	2.95	.0046	.0150	.19	.0180	.0000
2020	Mar. 15	Mar. 16	Slight.	Very slight.	0.20	3.65	0.90	2.75	.0031	.0122	.21	.0080	.0002
2263	Apr. 19	Apr. 20	Distinct.	Con., earthy and floc't.	0.25	6.30 2.65	0.70 0.65	5.60 2.00	.0000	.0116	.16	.0100	.0003
2450	May 17	May 18	Decided.	Much, earthy.	0.25	13.15 2.70	1.10 1.10	12.05 1.60	.0000	.0154 .0110	.09	.0030	.0001
2603	June 14	June 15	Very slight.	Sli't, earthy and floc't.	0.35	3.55	0.95	2.60	.0020	.0162 .0128	.16	.0100	.0003
2809	July 19	July 23	Very slight.	Very slight.	0.10	3.20	0.55	2.65	.0014	.0142 .0124	.19	.0050	.0001
2958	Aug. 16	Aug. 17	Slight.	Slight.	0.20	3.95	0.85	3.10	.0026	.0140 .0124	.22	.0070	.0002
2959	Aug. 16	Aug. 17	Slight.	Slight.	0.25	3.75	0.90	2.85	.0022	.0158 .0144	.22	.0080	.0003
2960	Aug. 16	Aug. 17	Slight.	Slight.	0.15	3.90	0.65	3.25	.0018	.0180 .0150	.22	.0070	.0002
3228	Sept. 20	Sept. 21	Slight.	Slight, earthy.	0.20	3.60	1.05	2.55	.0026	.0186 .0172	.16	.0080	.0005
3229	Sept. 20	Sept. 21	Slight.	Slight, earthy.	0.30	3.55	1.35	2.20	.0028	.0174 .0158	.15	.0030	.0004
3397	Oct. 18	Oct. 19	Slight.	Slight.	0.50	3.35	1.25	2.10	.0004	.0164 .0134	.11	.0070	.0002
3396	Oct. 18	Oct. 19	Slight.	Slight.	0.50	3.50	1.25	2.25	.0000	.0176 .0148	.13	.0060	.0003
3556	Nov. 15	Nov. 16	Slight.	Slight, earthy.	0.50	3.20	1.30	1.90	.0002	.0152 .0122	.10	.0150	.0002
	1889.												
3874	Jan. 17	Jan. 19	Slight, milky.	Considerable, earthy.	0.15	2.75	0.50	2.25	.0000	.0100 .0100	.12	.0050	.0004
4084	Feb. 21	Feb. 23	Slight.	Slight.	0.20	3.20	1.00	2.20	.0008	.0108 .0090	.16	.0180	.0004
4368	Mar. 21	Mar. 22	Distinct, milky.	Considerable, earthy.	0.20	2.85	1.00	1.85	.0000	.0150 .0114	.09	.0030	.0003
4536	Apr. 18	Apr. 19	Slight.	Considerable, earthy.	0.20	2.70	0.75	1.95	.0002	.0130 .0112	.08	.0020	.0002
4690	May 18	May 20	Slight.	Con., earthy and floc't.	0.20	3.25	0.95	2.30	.0032	.0156 .0138	.15	.0050	.0002
Av.	....	....	....	....	0.32	5.09	1.06	4.03	.0016	.0147	.15	.0087	.0002

Hardness in May, 1888, 0.6. Odor, very faintly vegetable, often none, occasionally mouldy.—— The samples were collected from the river opposite the inlet to the Lowell Water Works one foot beneath the surface. Nos. 2958 and 2959 are combined samples taken from many points in a line across the river. The former (2958) represents the north half and the latter (2959) represents the south half of the river. No. 3228 was from the middle of the north half of the river and No. 3229 from the middle of the south half. No. 3397 was from the north half of the river and No. 3396 from the south half of the river.

Microscopical Examination.

	1888.											1889.					
	June.	July.	Aug.	Aug.	Aug.	Sept.	Sept.	Oct.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ,	pr.	0.0	pr.	0.0	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	pr.
2. Other Algæ, .	4.2	0.9	2.4	5.7	4.3	1.8	2.6	pr.	0.5	1.7	0.2	0.3	0.2	0.5	0.9	0.3
3. Fungi, . .	0.1	0.1	0.0	0.0	pr.	pr.	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, .	0.0	0.1	pr.	0.2	0.2	pr.	0.1	0.0	0.0	0.0	pr.	0.0	pr.	pr.	0.0	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ, *Chlorococcus;* Zoosporeæ, *Scenedesmus;* Desmidiaceæ; Diatomaceæ, *Synedra, Tabellaria.* 3. Schizomycetes. 4. Protozoa; Rotifera.

Chemical Examination of Water from the Merrimack River above Lowell at the Inlet to the Lowell Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
104	June 14	June 15	Decided.	Consid'ble, brown.	0.30	4.20	1.50	2.70	.0019	.0119	.24	.0130	–
333	July 14	July 15	Very slight.	Very slight.	0.40	3.90	1.35	2.55	.0025	.0151	.14	.0070	–
577	Aug. 18	Aug. 19	Decided.	Slight, reddish brown.	0.50	5.62	0.85	4.77	.0129	.0131	.19	.0260	–
783	Sept. 15	Sept. 16	Slight.	Slight.	0.15	4.10	1.00	3.10	.0030	.0160	.21	.0070	–
1000	Oct. 20	Oct. 21	Very slight.	Very slight.	0.25	4.10	0.85	3.25	.0035	.0136	.21	.0080	–
1211	Nov. 17	Nov. 18	Decided.	Con., earthy and floc't.	0.75	5.35	1.05	4.30	.0026	.0246	.26	.0100	–
1417	Dec. 15	Dec. 16	Decided.	Con., earthy and floc't.	0.40	5.60	1.30	4.30	.0016	.0167	.18	.0100	–
	1888.												
1645	Jan. 19	Jan. 21	Slight.	Slight.	0.25	3.80	0.85	2.95	.0012	.0120	.14	.0290	.0001
1849	Feb. 16	Feb. 17	Slight.	Very slight.	0.35	3.70	0.75	2.95	.0056	.0157	.18	.0150	.0000
2022	Mar. 15	Mar. 16	Distinct.	Very slight.	0.20	3.65	0.85	2.80	.0034	.0106	.17	.0100	.0001
2265	Apr. 19	Apr. 20	Decided.	Much, brown.	0.35	7.15 2.90	0.80 0.80	6.35 2.10	.0022	.0126	.14	.0200	.0002
2451	May 17	May 18	Decided.	Much, earthy.	0.30	12.15 2.85	1.30 1.65	10.85 1.20	.0004	.0188 .0110	.11	.0080	.0000
2604	June 14	June 15	Slight.	Sli't, earthy and floc't.	0.30	3.70	0.80	2.90	.0056	.0142 .0124	.11	.0150	.0001
2810	July 19	July 21	Slight.	Sli't, earthy and floc't.	0.10	3.40	0.70	2.70	.0024	.0170 .0116	.18	.0050	.0002
Av.	....	....	....	....	0.33	5.28	1.04	4.24	.0035	.0151	.18	.0124	.0001

Hardness in May, 1888, 0.6. Odor, very faintly vegetable, often none, occasionally mouldy. —— The samples were collected in the inlet chamber where water comes in direct from the river and before it mingles with water from the filter-gallery or filter-inlet.

Microscopical Examination.

	1888.		
	May.	June.	July.
1. Blue-green Algæ,	0.0	0.0	0.0
2. Other Algæ,	pr.	2.5	7.9
3. Fungi,	0.0	pr.	2.0
4. Animal Forms,	0.0	0.1	0.1

Groups and principal genera of organisms observed: 2. Palmellaceæ, *Chlorococcus;* Zoosporeæ, *Tetraspora;* Desmidiaceæ; Diatomaceæ, *Synedra, Tabellaria.* 3. Schizomycetes, *Crenothrix.* 4. Protozoa; Rotifera; Entomostraca.

Chemical Examination of Water from the Conduit at the Bodwell Gate-house, Lowell.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
106	June 14	June 15	Slight.	Sli't, brown.	0.50	4.02	1.50	2.52	.0020	.0107	.17	.0060	–
334	July 14	July 15	Very slight.	Slight.	0.40	3.65	1.25	2.40	.0020	.0136	.16	.0070	–
579	Aug. 18	Aug. 19	Very slight.	Slight.	0.60	4.55	0.97	3.58	.0029	.0197	.19	.0130	–
785	Sept. 15	Sept. 16	Slight.	Sli't, earthy.	0.20	4.50	0.85	3.65	.0038	.0144	.21	.0130	–
1212	Nov. 17	Nov. 18	Decided.	Con., earthy and floc't.	0.75	5.25	1.45	3.80	.0038	.0206	.25	.0100	–
1418	Dec. 15	Dec. 16	Decided.	Consid'ble, earthy.	0.40	5.40	1.25	4.15	.0031	.0171	.17	.0180	–
	1888.												
1646	Jan. 19	Jan. 21	Slight.	Sli't, earthy.	0.20	3.95	1.05	2.90	.0024	.0116	.13	.0250	.0001
1847	Feb. 16	Feb. 17	Slight.	Very slight.	0.35	3.95	0.95	3.00	.0056	.0140	.18	.0200	.0000
2023	Mar. 15	Mar. 16	Distinct.	Very slight.	0.20	3.95	0.95	3.00	.0047	.0116	.18	.0200	.0001
2266	Apr. 19	Apr. 20	Distinct.	Sli't, brown.	0.30	3.85	1.10	2.75	.0020	.0113	.18	.0300	.0002
2452	May 17	May 18	Decided.	Slight, earthy.	0.30	6.05	0.95	5.10	.0022	.0144 .0098	.13	.0180	.0001
2811	July 19	July 21	Slight.	Sli't, earthy and floc't.	0.15	3.70	0.70	3.00	.0030	.0142 .0096	.19	.0200	.0001
2967	Aug. 17	Aug. 18	Slight.	Slight.	0.25	4.20	1.10	3.10	.0050	.0154 .0116	.20	.0200	.0001
3232	Sept. 20	Sept. 21	Very slight.	Slight.	0.30	3.95	1.10	2.85	.0036	.0140 .0138	.18	.0120	.0013
3398	Oct. 18	Oct. 19	Distinct.	Slight, green.	0.60	4.00	1.45	2.55	.0026	.0130 .0124	.18	.0250	.0004
3558	Nov. 15	Nov. 16	Slight.	Slight, earthy.	0.45	4.05	1.60	2.45	.0040	.0118 .0118	.17	.0250	.0002
3787	Dec. 20	Dec. 22	Decided.	Consid'ble, earthy.	0.35	3.10	1.20	1.90	.0000	.0166 .0118	.11	.0150	.0004

Chemical Examination of Water from the Conduit at the Bodwell Gate-house, Lowell — Concluded.

Number.	Date of Collection.	Date of Exam-ination.	Appearance: Turbidity.	Appearance: Sediment.	Appearance: Color.	Residue on Evaporation: Total.	Residue on Evaporation: Loss on Ignition.	Residue on Evaporation: Fixed.	Ammonia: Free.	Ammonia: Albu-minoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
3871	Jan. 17	Jan. 19	Slight, milky.	Consid'ble, earthy.	0.15	3.35	1.00	2.35	.0028	.0134 .0098	.16	.0180	.0004
4086	Feb. 21	Feb. 23	Distinct.	Slight	0.20	3.60	1.00	2.60	.0032	.0112 .0094	.20	.0300	.0004
4371	Mar. 21	Mar. 22	Distinct, milky.	Slight, earthy.	0.20	3.15	0.65	2.50	.0020	.0132 .0100	.13	.0040	.0003
4538	Apr. 18	Apr. 19	Slight.	Slight, earthy.	0.25	3.25	1.00	2.25	.0036	.0132 .0106	.13	.0150	.0002
4692	May 18	May 20	Distinct.	Con., earthy and floc't.	0.25	3.65	1.20	2.45	.0064	.0166 .0146	.16	.0100	.0002
Av.	....	....	....	....	0.33	4.47	1.12	3.35	.0032	.0142	.17	.0170	.0003

Hardness in May, 1888, 1.1. Odor, very faintly vegetable, often none, occasionally mouldy.—— The samples were collected from the conduit at the Bodwell gate-house. These samples are river water mixed with the water which comes from the filter-gallery, and show the quality of the water before it is pumped to the distributing reservoirs. The filter-inlet was cleaned July 14, 1888. The filter-gallery was cleaned soon after May 17, 1888.

Microscopical Examination.

	1888. July.	1888. Aug.	1888. Sept.	1888. Oct.	1888. Nov.	1888. Dec.	1889. Jan.	1889. Feb.	1889. Mar.	1889. Apr.	1889. May.
1. Blue-green Algæ, ...	0.1	0.0	0.0	0.0	0.0	–	0.0	0.0	0.0	pr.	0.0
2. Other Algæ, ...	2.5	1.3	0.7	0.4	0.2	–	1.7	0.4	0.8	1.5	0.8
3. Fungi, ...	0.4	0.3	0.0	0.0	0.0	–	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, ...	pr.	pr.	pr.	0.0	0.0	–	0.1	0.0	pr.	pr.	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Melosira*, *Synedra*. 3. Schizomycetes. 4. Protozoa.

Chemical Examination of Water from the Low-Service Distributing Reservoir, Lowell.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Exam-ination.	Appearance: Turbidity.	Appearance: Sediment.	Appearance: Color.	Residue on Evaporation: Total.	Residue on Evaporation: Loss on Ignition.	Residue on Evaporation: Fixed.	Ammonia: Free.	Ammonia: Albu-minoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
105	June 14	June 15	Decided.	Very slight.	0.30	3.70	1.07	2.63	.0002	.0126	.17	.0150	–
335	July 14	July 15	None.	Very slight.	0.40	3.92	1.05	2.87	.0013	.0152	.16	.0130	–
578	Aug. 18	Aug. 19	Very slight.	Very slight.	0.60	4.35	1.25	3.10	.0025	.0195	.13	.0130	–

Chemical Examination of Water from the Low-Service Distributing Reservoir, Lowell — Concluded.

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.	Chlorine.	Nitrates.	Nitrites.
	1887.												
784	Sept. 15	Sept. 16	Slight.	Sli't, earthy.	0.20	4.40	1.35	3.05	.0020	.0152	.22	.0260	–
1002	Oct. 20	Oct. 21	Slight.	Con., e'rthy.	0.30	4.60	0.80	3.80	.0026	.0163	.24	.0200	–
1213	Nov. 19	Nov. 21	Slight.	Slight.	0.40	4.45	1.20	3.25	.0042	.0189	.24	.0180	–
1419	Dec. 15	Dec. 16	Distinct.	Very slight.	0.40	5.00	1.10	3.90	.0060	.0138	.22	.0200	–
	1888.												
1647	Jan. 19	Jan. 21	Slight.	Sli't, earthy.	0.30	3.95	1.00	2.95	.0026	.0120	.17	.0250	.0001
1846	Feb. 16	Feb. 17	Slight.	Slight.	0.35	3.85	0.95	2.90	.0062	.0151	.19	.0200	.0000
2024	Mar. 15	Mar. 16	Distinct.	Slight.	0.25	3.95	1.25	2.70	.0041	.0109	.18	.0200	.0001
2267	Apr. 19	Apr. 20	Distinct.	Very slight.	0.10	3.50	0.95	2.55	.0038	.0124	.18	.0300	.0002
2453	May 17	May 18	Decided.	Sli't, earthy.	0.20	3.25	1.15	2.10	.0018	.0130 .0086	.12	.0200	.0001
2605	June 14	June 15	Distinct.	Sli't, earthy and floc't.	0.30	3.50	1.10	2.40	.0006	.0142 .0124	.17	.0200	.0001
2812	July 19	July 21	Very slight.	Sli't, earthy and floc't.	0.15	3.90	0.85	3.05	.0030	.0128 .0112	.20	.0200	.0001
2968	Aug. 17	Aug. 18	Slight.	Sli't, brown.	0.15	3.85	1.05	2.80	.0020	.0148 .0120	.21	.0100	.0001
3233	Sept. 20	Sept. 21	Slight.	Slight.	0.20	3.80	0.85	2.95	.0022	.0140 .0126	.19	.0080	.0006
3399	Oct. 18	Oct. 19	Distinct.	Sli't, green.	0.60	4.20	1.35	2.85	.0030	.0142 .0124	.17	.0250	.0003
3560	Nov. 15	Nov. 16	Slight.	Sli't, brown.	0.40	3.75	1.10	2.65	.0024	.0140 .0114	.17	.0280	.0003
3786	Dec. 20	Dec. 22	Distinct.	Con., floc't.	0.25	3.70	0.75	2.95	.0032	.0124 .0096	.19	.0080	.0003
	1889.												
3873	Jan. 17	Jan. 19	Sli't, milky.	Sli't, earthy.	0.15	3.60	0.95	2.65	.0028	.0098 .0084	.17	.0080	.0003
4087	Feb. 21	Feb. 23	Very slight.	Consid'ble.	0.15	3.40	1.05	2.35	.0034	.0114 .0080	.16	.0300	.0004
4370	Mar. 21	Mar. 22	Distinct, milky.	Sli't, earthy and floc't.	0.20	3.20	1.00	2.20	.0030	.0124 .0094	.14	.0050	.0003
4539	Apr. 18	Apr. 19	Slight.	Sli't, earthy.	0.25	3.10	1.00	2.10	.0018	.0134 .0106	.12	.0100	0002
4693	May 18	May 20	Distinct.	Consid'ble.	0.15	3.40	1.05	2.35	.0026	.0144 .0110	.15	.0120	.0001
Av.	....	....	....	....	0.28	4.15	1.09	3.06	.0028	.0139	.18	.0177	0002

Hardness in May, 1888, 1.1. Odor, very faintly vegetable, often none, occasionally mouldy. —— The samples were collected from the outlet of the reservoir where the water flows into the distributing pipes.

Microscopical Examination.

	1888.								1889.				
	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ,	0.0	0.0	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ,	pr.	4.7	pr.	2.8	0.7	pr.	0.0	0.7	1.2	pr.	0.5	0.4	0.1
3. Fungi,	0.0	0.8	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	pr.
4. Animal Forms,	0.0	0.3	pr.	pr.	pr.	pr.	0.0	0.0	0.0	0.0	0.1	pr.	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ, *Chlorococcus;* Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Synedra, Tabellaria.* 3. Schizomycetes. 4. Protozoa; Spongiaria; Entomostraca.

WATER SUPPLY OF LUDLOW.

Description of Works. — Population in 1885, 1,649. The distributing system is owned by the Ludlow Manufacturing Company. Water is purchased of the city of Springfield and was introduced in 1873. *See Springfield.*

Chemical Examination of Water from Wood's Pond, Ludlow.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1889.												
4266	Mar. 9	Mar. 11	Distinct.	Slight.	0.05	1.50	0.85	0.65	.0004	.0234 .0184	.09	.0060	.0003

Hardness, 0.2. Odor, faintly grassy.—— Wood's Pond has a very small drainage area and no stream enters it. It is quite shallow and has a sandy bottom. The sample was collected at a point where the water was 9½ feet in depth. The pond was frozen over, the ice being 6 inches thick.

Microscopical Examination.

1. Blue-green algæ, 0.0; 2. Other algæ, 1.2; 3. Fungi, 0.0; 4. Animal forms, 5.0.

Groups and principal genera of organisms observed: 2. Diatomaceæ, *Asterionella;* Desmidiaceæ. 4. Protozoa, *Dinobryon.*

Chemical Examination of Water from Chapin's Pond, Ludlow.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.	1889.											
4267	Mar. 9	Mar. 11	Very slight.	None.	0.05	1.50	0.60	0.90	.0006	.0180 .0160	.08	.0050	.0006

Hardness, 1.2. Odor, very faint or none.——Chapin's Pond has a very small drainage area and the soil about it is sandy. At the time the sample was collected the pond was frozen over, the ice being 6 inches thick.

Microscopical Examination.

1. Blue-green algæ, 0.0; 2. Other algæ, 1.5; 3. Fungi, 0.0; 4. Animal forms, 0.1.

Groups and principal genera of organisms observed: 2. Diatomaceæ, *Asterionella;* Desmidiaceæ. 4. Protozoa.

Water Supply of Lynn.

Description of Works.—Population in 1885, 45,867. The works are owned by the city and were built in 1871. The average daily consumption in 1888 was 2,475,000 gallons. The sources of supply are Breed's Pond, Birch Pond, Hawkes Brook and Penny Brook; two storage reservoirs have recently been built on Penny Brook. The city has also authority to take water from the Saugus River whenever its daily flow at Pranker's Dam exceeds twelve million gallons; but this authority has never been exercised. The upper reservoir on Penny Brook is known as Glen Lewis Pond and the lower one as Walden Pond. Breed's Pond is in Lynn; the other ponds and brooks are partially or wholly in Saugus.

Water from Birch and Breed's ponds flows by gravity through cast-iron pipes to a pumping station, from which it is forced to a distributing reservoir. The pipes from the ponds have been connected at a point near the pumping station, and water can be passed from one pond to the other when the pumps are not in use. The water of Hawkes and Penny brooks is conveyed by a canal to the inlet gate-house at the upper end of Birch Pond, from which it passes to the outlet gate-house through a 30-inch pipe laid on the bottom of the pond. From the outlet gate-house the water passes through the main pipe to the pumping station.

The total length of the main canal is 5,906 feet from its junction

with the branch canal from Hawkes Brook to the tunnel which conveys the water through the divide to Birch Pond. The tunnel is 1,358 feet long. There is a short piece of brick conduit 337 feet in length between the tunnel and the inlet gate-house at Birch Pond. The branch canal from Hawkes Brook to the main canal is 3,000 feet long and the branch canal from the lower dam on Penny Brook is 1,240 feet long. The canals were built in 1884.

The following table gives statistics relating to the storage reservoirs of the Lynn Water Works: —

	Areas of Watersheds including Water Surfaces.		Area of Water Surface.	Total Storage Capacity of Reservoir.	Available Storage Capacity of Reservoir.*	Average Depth of Reservoir.	Maximum Depth of Reservoir.
	Exclusive of Watersheds of Reservoirs above. (Sq. Miles.)	Total Contributing Watershed. (Sq. Miles.)	(Acres.)	(U. S. Gallons.)	(U. S. Gallons.)	(Feet.)	(Feet.)
Breed's Pond, .	–	0.92	58.5	244,000,000	230,900,000	12.8	22.0
Birch Pond, . .	–	0.79	82.0	390,000,000	349,600,000	14.6	21.5
Glen Lewis Pond,	–	0.36	36.0	106,000,000	100,100,000	9.0	16.0
Walden Pond, .	1.31	1.67	128.0	360,000,000	311,400,000	8.6	16.0

* This is the capacity of the reservoir above a plane 6 feet above the bottom at the dam.

Breed's Pond is an artificial reservoir and was built in 1846 to furnish water power for a mill. It was selected as a source of supply for Lynn in 1871, and in 1878 the dam was raised three feet, thus increasing the size of the pond to its present dimensions. The bottom of the pond is muddy, and about one-third of its area is less than ten feet in depth at high water.

Birch Pond is an artificial reservoir and was built in 1872. The trees and brush were removed from the bottom and sides of the reservoir, but it was not otherwise cleaned. In 1885 the height of the dam was increased about nine feet, and it is now level with the dam of Breed's Pond. The pond is long and narrow with steep and rocky shores, and the bottom is nearly level throughout the length of the pond, so that there are no considerable areas of shallow flowage.

Glen Lewis Pond and Walden Pond were filled for the first time in the latter part of the year 1889. The basins are contiguous, the

water of Walden Pond touching the base of the dam at Glen Lewis Pond. The surface of Glen Lewis Pond at high water is six feet higher than the surface of Walden Pond. The bottoms of these ponds were cleared of brush and wood, but the surface of the ground was not disturbed excepting for the purpose of obtaining material for the construction of the dams.

The drainage areas of Birch and Breed's ponds and Hawkes and Penny brooks are contiguous and very similar in character and contain very few inhabitants. All are hilly, rocky and well wooded. There is considerable swamp land on the drainage areas of Hawkes and Penny brooks.

The drainage area of Birch Pond is small in comparison with the capacity of the pond, and consequently when drawn very low in the early part of the winter there is danger that it will not fill up again before the next summer. The water of the canal will not flow into Birch Pond by gravity when the water in the latter is above seven feet in depth at the dam, and in order to fill Birch Pond from the canal a pump has been set up temporarily at the inlet gate-house and water may be pumped from the canal into Birch Pond when necessary.

The area of the distributing reservoir is 5 acres and its depth at high water is 15 feet. It is divided into two compartments by a wall through the middle, and its total capacity is 19,500,000 gallons. The bottom is covered with a layer of clay puddle over which is a layer of small stones. The slopes are paved. Distributing mains and service pipes are of wrought iron lined with cement. Extensions to the distributing mains are now made with cast iron, and the cement-lined mains in the business part of the city are being removed and cast-iron ones substituted.

A system of tubular wells was constructed in 1880, and water was pumped from them into Breed's Pond and thence distributed to the city. In the winter of 1882–83 the ponds did not fill up, and the water from the tubular wells saved the city from a water famine during the year 1883. Since the construction of the canal in 1884 the wells have not been used.

Chemical Examination of Water from Breed's Pond, Lynn.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
171	June 21	June 23	Very slight.	Slight.	0.50	3.85	1.47	2.38	.0012	.0169	.44	.0000	–
377	July 21	July 22	Slight.	None.	0.50	3.42	1.00	2.42	.0000	.0186	.45	.0050	–
593	Aug. 22	Aug. 23	Distinct.	None.	0.40	3.20	0.70	2.50	.0000	.0165	.38	.0000	–
817	Sept. 19	Sept. 20	Very slight.	Sli't, brown.	0.30	3.70	1.30	2.40	.0002	.0237	.46	.0000	–
1004	Oct. 20	Oct. 21	Distinct.	Sli't, brown.	0.50	3.85	1.50	2.35	.0000	.0284	.44	.0020	–
1242	Nov. 21	Nov. 22	Distinct.	Slight.	0.70	3.60	1.50	2.10	.0004	.0251	.46	.0050	–
1461	Dec. 20	Dec. 22	Distinct.	Sli't, earthy.	0.70	4.25	1.80	2.45	.0024	.0225	.48	.0050	.0000
	1888.												
1639	Jan. 19	Jan. 20	Distinct.	Very slight.	0.45	4.45	1.90	2.55	.0024	.0205	.46	.0090	–
1854	Feb. 16	Feb. 18	Slight.	Very slight.	0.60	5.05	1.90	3.15	.0129	.0225	.69	.0080	.0000
2010	Mar. 15	Mar. 16	Distinct.	Very slight.	0.50	4.35	1.55	2.80	.0074	.0252	.50	.0080	.0001
2258	Apr. 19	Apr. 20	Distinct.	Sli't, white.	0.40	2.95	1.10	1.85	.0001	.0207	.41	.0020	.0001
2445	May 17	May 18	Slight.	Slight.	0.35	3.45	1.35	2.10	.0016	.0174	.41	.0000	.0001
2663	June 25	June 26	Distinct.	Sli't, green.	0.60	3.00	1.10	1.90	.0006	.0189 .0170	.43	.0050	.0000
2803	July 19	July 20	Distinct.	Sli't, white.	0.70	3.35	1.30	2.05	.0000	.0238 .0200	.41	.0000	.0001
2951	Aug. 16	Aug. 17	Distinct.	Sli't, green.	0.50	3.25	1.05	2.20	.0012	.0246 .0178	.42	.0000	.0001
3218	Sept. 18	Sept. 19	Slight.	Slight.	0.30	3.35	1.25	2.10	.0008	.0280 .0180	.40	.0030	.0002
3402	Oct. 18	Oct. 19	Slight.	Sli't, green.	0.60	3.50	1.40	2.10	.0010	.0252 .0180	.40	.0070	.0004
3561	Nov. 15	Nov. 16	Slight.	Very slight.	0.70	3.90	1.45	2.45	.0048	.0264 .0216	.41	.0120	.0003
3697	Dec. 11	Dec. 12	Slight.	Slight.	0.00	3.90	1.70	2.20	.0020	.0200 .0144	.43	.0090	.0001
	1889.												
3850	Jan. 15	Jan. 16	Slight.	Very slight.	0.60	3.20	1.05	2.15	.0000	.0196 .0150	.43	.0070	.0004
4059	Feb. 20	Feb. 21	None.	Very slight.	0.35	3.15	1.15	2.00	.0024	.0146 .0130	.44	.0050	.0003
4358	Mar. 20	Mar. 21	Very slight.	Slight.	0.30	3.05	1.05	2.00	.0002	.0166 .0118	.40	.0030	.0001
4527	Apr. 17	Apr. 18	Decided.	Slight.	0.50	2.95	0.90	2.05	.0002	.0190 .0138	.38	.0020	.0001
4675	May 16	May 17	Slight.	Con., white.	0.40	3.10	0.95	2.15	.0002	.0200 .0168	.40	.0030	.0000
Av.	....	....	....	....	0.48	3.84	1.42	2.42	.0018	.0214	.44	.0042	.0001

Hardness in May, 1888, 0.6. Odor, vegetable, often disagreeable.——The samples were collected from the pond near the gate-house. No. 171 was collected 4 feet beneath the surface and the others at about 8 inches beneath the surface. For heights of water in this pond at the times when samples of water were collected for analysis, see page 209.

Microscopical Examination.

	1888.							1889.				
	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ,	pr.	0.0	pr.	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.1
2. Other Algæ,	30.0	0.0	3.1	30.8	1.5	4.7	5.5	3.4	1.0	60.3	12.5	6.6
3. Fungi,	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms,	pr.	pr.	0.3	0.9	pr.	0.0	0.1	0.0	0.2	86.0	2.8	0.1

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Asterionella*, *Tabellaria*. 3. Schizomycetes. 4. Protozoa, *Dinobryon*, *Peridinium*; Spongiaria; Rotifera; Entomostraca.

Chemical Examination of Water from Birch Pond, Lynn.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
173	June 21	June 23	Distinct.	Consid'ble.	0.40	3.90	1.72	2.18	.0044	.0261	.39	.0060	–
376	July 21	July 22	Slight.	Slight.	0.70	3.92	1.40	2.52	.0003	.0292	.37	.0000	–
594	Aug. 22	Aug. 23	Slight.	Very slight.	0.60	4.22	1.25	2.97	.0004	.0196	.39	.0000	–
816	Sept. 19	Sept. 20	Distinct.	Considerable, brown.	0.60	4.30	1.70	2.60	.0005	.0392	.45	.0030	–
1003	Oct. 20	Oct. 21	Distinct.	Consid'ble.	0.60	4.20	1.75	2.45	.0000	.0204	.46	.0080	–
1241	Nov. 21	Nov. 22	Slight.	Sli't, white.	0.70	3.75	1.80	1.95	.0004	.0338	.47	.0060	–
1460	Dec. 20	Dec. 22	Distinct.	Slight.	0.40	3.85	1.65	2.20	.0051	.0337	.47	.0080	.0000
	1888.												
1638	Jan. 19	Jan. 20	Very slight.	Very slight.	0.40	4.30	2.10	2.20	.0085	.0314	.49	.0230	–
1853	Feb. 16	Feb. 18	Distinct.	Slight.	0.45	4.20	1.90	2.30	.0131	.0315	.65	.0150	.0001
2011	Mar. 15	Mar. 16	Distinct.	Slight.	0.15	2.70	1.15	1.55	.0017	.0300	.36	.0050	.0000
2259	Apr. 19	Apr. 20	Decided.	Slight.	0.45	3.25	1.10	2.15	.0018	.0250	.43	.0030	.0002
2444	May 17	May 18	Distinct.	Sli't, earthy and floc't.	0.20	4.40	1.50	2.90	.0000	.0242	.46	.0050	.0000
2664	June 25	June 26	Distinct.	Sli't, green.	0.45	3.20	1.25	1.95	.0022	.0248 .0194	.44	.0030	.0001
2804	July 19	July 20	Slight.	Sli't, green.	0.35	3.40	1.35	2.05	.0008	.0262 .0216	.41	.0000	.0001
2952	Aug. 16	Aug. 17	Decided.	Sli't, green.	0.25	3.25	1.10	2.15	.0000	.0282 .0174	.45	.0020	.0001
3217	Sept. 18	Sept. 19	Distinct.	Con., green.	0.30	3.40	1.20	2.20	.0016	.0394 .0204	.43	.0030	.0002
3403	Oct. 18	Oct. 19	Distinct.	Sli't, green.	0.30	3.05	1.30	1.75	.0004	.0304 .0236	.41	.0090	.0004
3562	Nov. 15	Nov. 16	Slight.	Very slight.	0.30	3.30	1.25	2.05	.0014	.0310 .0258	.42	.0150	.0002
3698	Dec. 11	Dec. 12	Slight.	Slight.	0.35	3.35	1.55	1.80	.0002	.0222 .0162	.45	.0150	.0001

Chemical Examination of Water from Birch Pond, Lynn — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
3851	Jan. 15	Jan. 16	Slight.	Very slight.	0.30	–	–	–	.0000	.0182	.42	.0100	.0003
4058	Feb. 20	Feb. 21	Very slight.	Sli't, green.	0.10	2.95	1.05	1.90	.0008	.0162 .0156	.45	.0050	.0002
4357	Mar. 20	Mar. 21	Slight.	Slight.	0.15	3.20	1.30	1.90	.0000	.0238 .0164	.41	.0050	.0002
4526	Apr. 17	Apr. 18	Decided.	Very slight.	0.10	2.85	1.25	1.60	.0004	.0230 .0150	.39	.0030	.0001
4674	May 16	May 17	Slight.	Con., green.	0.10	2.85	0.95	1.90	.0012	.0254 .0200	.39	.0030	.0001
Av.	....	....	....	....	0.36	3.92	1.59	2.33	.0019	.0272	.44	.0065	.0001

Hardness in May, 1888, 0.8. Odor, faintly vegetable, often mouldy and disagreeable.—— The samples were collected from the pond near the gate-house. For heights of water in this pond at the times when samples of water were collected for analysis, see page 209.

Microscopical Examination.

	1888. June.	1888. July.	1888. Aug.	1888. Sept.	1888. Oct.	1888. Nov.	1888. Dec.	1889. Jan.	1889. Feb.	1889. Mar.	1889. Apr.	1889. May.
1. Blue-green Algæ, ...	0.3	0.4	0.2	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1
2. Other Algæ, ...	2.1	4.4	8.2	20.9	3.8	0.0	6.1	1.5	4.1	2.3	0.6	5.1
3. Fungi, ...	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	pr.	0.0	0.0	0.0
4. Animal Forms, ...	pr.	0.5	0.1	1.5	0.2	0.4	0.2	0.2	0.5	3.5	0.6	1.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ, *Scenedesmus*, *Staurogenia;* Desmidiaceæ; Diatomaceæ, *Asterionella*, *Tabellaria;* Volvocineæ. 3. Schizomycetes. 4. Protozoa, *Dinobryon*, *Peridinium*, *Trachelomonas;* Spongiaria; Rotifera; Entomostraca.

Chemical Examination of Water from Hawkes Brook, Lynn Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
172	June 21	June 23	Very slight.	Slight.	0.30	5.15	1.92	3.23	.0022	.0165	.56	.0060	–
	1888.												
2446	May 17	May 18	Very slight.	Slight.	0.75	4.35	1.90	2.45	.0000	.0200	.36	.0030	.0001

Hardness in May, 1888, 1.3. Odor, faintly vegetable.—— Sample No. 172 was collected from Hawkes Brook near its junction with Penny Brook at a time when the brook was very low. No. 2446 was collected from the brook at the same place. The brook was not being used as a source of supply for the city of Lynn at the time the samples were collected.

Microscopical Examination.

May, 1888. 1. Blue-green algæ, 0.0; 2. Other algæ, pr.; 3. Fungi, 0.0; 4. Animal forms, 0.0. Groups and principal genera of organisms observed: 2. Zoosporeæ; Diatomaceæ.

Chemical Examination of Water from Penny Brook, Lynn Water Works.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1887.												
169	June 21	June 23	Decided.	Consid'ble.	1.7	6.55	2.80	3.75	.0038	.0432	.39	.0190	–
	1888.												
2447	May 17	May 18	Very slight.	Slight.	1.6	4.50	2.25	2.25	.0000	.0240	.32	.0050	.0001

Hardness in May, 1888, 1.0. Odor, vegetable. —— The samples were collected from Penny Brook near its junction with Hawkes Brook. The brook was not in use at the time sample No. 2447 was collected.

Microscopical Examination.

May, 1888. 1. Blue-green algæ, 0.0; 2. Other algæ, pr.; 3. Fungi, pr.; 4. Animal forms, pr. Groups and principal genera of organisms observed: 2. Zoosporeæ; Diatomaceæ. 3. Schizomycetes. 4. Spongiaria.

Chemical Examination of Water from the Canal, Lynn Water Works.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1889.												
4528	Apr. 17	Apr. 18	Slight.	Very slight.	0.9	3.55	1.40	2.15	.0006	.0198 .0176	.36	.0060	.0001

Odor, very faint or none. —— The sample was collected from the canal which conveys water from Hawkes and Penny brooks to Birch Pond and the pumping station.

Microscopical Examination.

April, 1889. 1. Blue-green algæ, 0.0; 2. Other algæ, 0.1; 3. Fungi, 0.0; 4. Animal forms, 0.0. Groups and principal genera of organisms observed: 2. Diatomaceæ; Desmidiaceæ.

Chemical Examination of Water from the Distributing Reservoir of the Lynn Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
170	June 21	June 23	Decided.	Slight.	0.50	4.12	1.65	2.47	.0026	.0254	.43	.0000	–
378	July 21	July 22	Very slight.	None.	0.60	3.85	1.25	2.60	.0015	.0278	.37	.0130	–
595	Aug. 22	Aug. 23	Very slight.	Slight.	0.70	3.82	0.70	3.12	.0004	.0196	.39	.0030	–
818	Sept. 19	Sept. 20	Slight.	Sli't, brown.	0.35	3.75	1.30	2.45	.0000	.0263	.46	.0000	–
1005	Oct. 20	Oct. 21	Distinct.	Sli't, brown.	0.50	4.00	1.45	2.55	.0000	.0254	.46	.0000	–
1243	Nov. 22	Nov. 22	Distinct.	Sli't, brown.	0.65	4.20	1.80	2.40	.0008	.0228	.48	.0000	–
1462	Dec. 20	Dec. 22	Slight.	Sli't, earthy.	1.20	5.25	1.95	3.30	.0014	.0244	.50	.0080	.0000
	1888.												
1640	Jan. 19	Jan. 20	Slight.	None.	0.65	4.90	1.95	2.95	.0000	.0148	.75	.0180	–
1855	Feb. 16	Feb. 18	Very slight.	Sli't, white.	0.70	5.05	1.60	3.45	.0064	.0216	.59	.0120	.0000
2012	Mar. 15	Mar. 16	Slight.	Slight.	0.50	4.20	1.55	2.65	.0057	.0209	.46	.0100	.0001
2260	Apr. 19	Apr. 20	Slight.	Slight.	0.45	3.80	1.10	2.70	.0000	.0186	.39	.0080	.0001
2448	May 17	May 18	Slight.	Very slight.	0.60	3.75	1.30	2.45	.0004	.0190	.40	.0080	.0001
Av.	....	....	....	....	0.62	4.22	1.47	2.75	.0016	.0222	.47	.0067	–

Hardness in May, 1888, 0.9. Odor, vegetable, frequently mouldy and disagreeable.—— The samples were collected from the reservoir.

Microscopical Examination.

	1888. March.	1888. April.	1888. May.
1. Blue-green Algæ, ...	0.0	0.0	0.0
2. Other Algæ, ...	pr.	pr.	pr.
3. Fungi, ...	0.0	0.0	0.0
4. Animal Forms, ...	pr.	pr.	pr.

Groups and principal genera of organisms observed: 2. Palmellaceæ; Desmidiaceæ; Diatomaceæ. 4. Protozoa.

Table showing Heights of Water in Birch and Breed's Ponds at the Times when Samples of Water were collected for Analysis.

[Heights are in feet above the Lynn city base.]

DATE.	Breed's Pond. High Water, 21.00.	Birch Pond. High Water, 21.75.
1887.		
June 21,	20.69	20.25
July 21,	20.42	16.71
August 22,	18.71	15.42
September 19,	16.21	15.21
October 20,	12.60	15.00
November 21,	9.54	15.00
December 20,	8.98	15.46
1888.		
January 19,	10.71	16.44
February 16,	7.44	16.75
March 15,	13.00	18.25
April 19,	20.62	22.00
May 17,	21.10	22.15
June 25,	19.25	21.29
July 19,	17.54	19.35
August 16,	15.40	17.50
September 18,	13.50	15.42
October 18,	15.44	15.48
November 15,	17.62	16.40
December 11,	20.71	20.73
1889.		
January 15,	20.00	22.12
February 20,	19.88	21.42
March 20,	19.71	21.29
April 17,	20.50	21.33
May 16,	20.88	21.58

Chemical Examination of Water from Flax Pond, Lynn.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
3157	Sept. 11	Sept. 12	Slight.	Slight.	0.05	6.05	1.05	5.00	.0036	.0292 .0246	0.89	.0070	.0003
3351	Oct. 10	Oct. 11	Slight.	Sli't, green.	0.20	5.95	1.35	4.60	.0254	.0192 .0162	0.98	.0250	.0009
3352	Oct. 10	Oct. 11	Distinct.	Slight.	0.20	6.10	1.40	4.70	.0370	.0240 .0160	1.04	.0250	.0011
	1889.												
4109	Feb. 25	Feb. 25	Distinct.	Slight.	0.20	5.55	2.35	3.20	.0010	.0120 .0104	0.72	.0400	.0003
Av.	....	....	....	....	0.16	5.91	1.54	4.37	.0168	.0211 .0168	0.91	.0243	.0007

Odor, vegetable and disagreeable.—— The samples were collected from the pond at the upper end, opposite the ice-houses of Mansfield & Co., with the exception of No. 3351, which was collected from the lower end of the pond.

Microscopical Examination.

September, 1888. 1. Blue-green algæ, 0.0; 2. Other algæ, 25.4; 3. Fungi, pr.; 4. Animal forms, 0.5. Groups and principal genera of organisms observed: 2. Palmellaceæ, *Chlorococcus;* Zoosporeæ, *Scenedesmus, Staurogenia;* Diatomaceæ, *Melosira;* Desmidiaceæ. 3. Schizomycetes. 4. Protozoa; Rotifera; Entomostraca.

LYNNFIELD.

Chemical Examination of Water from Pilling's Pond in Lynnfield.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
3456	Oct. 26	Oct. 29	None.	None.	1.40	6.95	3.15	3.80	.0016	.0290 .0272	.45	.0020	.0002
3457	Oct. 26	Oct. 29	Slight.	Very slight.	0.55	4.75	2.05	2.70	.0064	.0276 .0238	.36	.0020	.0002
3798	Dec. 27	Dec. 28	Slight.	Very slight.	0.45	4.85	1.60	3.25	.0014	.0220 .0194	.46	.0040	.0002
Av.	....	....	....	....	0.50	4.80	1.82	2.98	.0044	.0248 .0216	.41	.0030	.0002

Odor, faintly vegetable.——Sample No. 3456 was collected from brook which runs into Pilling's Pond. Nos. 3457 and 3798 were collected from the pond at the dam. Sample No. 3456 is omitted from the average.

Microscopical Examination.

	1888. Oct.	1888. Oct.	1888. Dec.
1. Blue-green Algæ, ...	0.0	0.0	0.0
2. Other Algæ, ...	0.1	pr.	pr.
3. Fungi, ...	0.0	0.0	0.0
4. Animal Forms, ...	0.0	pr.	0.0

Groups and principal genera of organisms observed: 2. Diatomaceæ. 4. Protozoa.

Chemical Examination of Water from Suntaug Lake in Lynnfield.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
3458	Oct. 26	Oct. 29	Very slight.	Very slight.	0.0	3.20	0.90	2.30	.0006	.0146 .0146	.59	.0020	.0000
	1889.												
4189	Mar. 1	Mar. 2	Very slight.	Very slight.	0.0	3.45	1.45	2.00	.0000	.0174 .0120	.63	.0070	.0001
4571	Apr. 24	Apr. 26	Very slight.	Sli't, gray, floc't.	0.0	3.70	1.30	2.40	.0036	.0240 .0202	.61	.0090	.0001
4715	May 22	May 23	Slight.	Very slight.	0.0	3.40	1.05	2.35	.0024	.0176 .0126	.60	.0030	.0000
Av.	....	....	....	....	0.0	3.44	1.18	2.26	.0017	.0184 .0149	.61	.0053	–

Odor, faintly vegetable or mouldy. —— The samples were collected from the lake at the surface. No. 3458 was collected about 10 feet from shore, south side. No. 4189 was collected 50 feet from shore, south side. No. 4571 was collected 200 feet from shore, north side. No. 4715 was collected 400 feet from shore, west side.

Microscopical Examination.

	1888. Oct.	1889. Mar.	1889. Apr.	1889. May.
1. Blue-green Algæ,	pr.	0.0	0.0	0.0
2. Other Algæ,	0.2	1.0	4.1	1.8
3. Fungi,	0.0	pr.	0.0	0.0
4. Animal Forms,	0.9	pr.	12.0	pr.

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Diatomaceæ, *Synedra*, *Stephanodiscus*; Zoosporeæ. 3. Schizomycetes. 4. Protozoa, *Dinobryon*.

Water Supply of Malden.

Description of Works. — Population in 1885, 16,407. The works are owned by the city. The original works were built in 1870. The average daily consumption for the last six months of 1888 was estimated to be about 1,000,000 gallons. There are two distinct sources of supply, — Spot Pond in Stoneham and a system of tubular wells at Webster Park in Malden. The city has also the right to take the waters of Martin's Pond in North Reading.

The original source of supply is Spot Pond in Stoneham. The area of this pond at high water is 296 acres and its maximum depth is 37 feet; the bottom is generally muddy. There are 61 acres of the pond, nearly all of it at one end, where the water does not exceed six feet in depth when the pond is full. The remaining portions of the pond are quite deep and the shores are generally abrupt. Its capacity, above a plane 8 feet below high water, is 554,000,000 gallons, and above a plane 15 feet below high water the capacity is 837,000,000 gallons. The watershed of the pond, by a careful examination of the ground and an estimate from the new topographical map of Massachusetts, is found to be 1,296 acres, including the area of the pond. It is generally very rocky and covered with a growth of wood, though it contains also considerable areas of swamp land. There is one pond on the watershed, known as Doleful Pond, which has an area of about 7.5 acres. The watershed contains at the present time few inhabitants, but the village of Stoneham, which is located just outside the watershed, is beginning to encroach upon it.

Water from Spot Pond can be supplied to the city by gravity, but pumping is resorted to much of the time as the pressure of the gravity supply is small. Distributing mains are of wrought iron lined with cement. Service pipes are nearly all of lead. Extensions of the distributing mains are made with cast-iron pipes.

The second source of supply is a system of tubular wells located at Webster Park, formerly known as Eaton's Meadows, in Malden. There are 51 wells in all, sunk to rock at an average depth of 65 feet. The direct watershed supplying the wells was estimated, after a careful examination, to be a little less than one square mile. The population on this area is estimated to be about 2,400. Some other watersheds, containing a still larger area, probably contribute some water to the wells. Pumps force the water from the wells to a covered iron tank 75 feet in diameter and 35 feet in height. Water from this system is generally used for high-service distribution, but may be supplied to any part of the city. Distributing mains are of cast iron. Service pipes are of lead.

A disagreeable odor and taste in the water of the pond has been complained of during several years since the works were built, and was very serious in May and June, 1887, but there has been no serious recurrence of this trouble since that year.

The towns of Medford and Melrose also obtain their supply of water from Spot Pond, each town being entitled to one-third of the water of the pond. For analyses of water from Martin's Pond, see *North Reading*.

Chemical Examination of Water from Spot Pond in Stoneham.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.		Nitrates.	Nitrites.
	1887.												
9	May 24	May 25	Decided.	Slight.	–	4.55	1.43	3.12	.0015	.0210	–	–	–
10	May 24	May 25	Decided.	Slight.	–	4.23	1.73	2.50	.0028	.0226	–	–	–
217	June 29	June 29	Slight.	Slight.	0.30	4.22	1.37	2.85	.0003	.0213	.45	.0000	–
226	June 30	July 1	Slight.	Slight.	0.30	4.40	1.12	3.28	.0002	.0255	.44	.0020	–
245	July 2	July 2	Slight.	None.	0.20	5.30	1.30	4.00	.0002	.0161	.46	.0070	–
440	July 29	July 29	Very slight.	None.	0.35	4.12	0.42	3.70	.0000	.0144	.43	.0030	–
442	July 29	July 29	Very slight.	Sli't, rusty.	0.20	4.35	0.55	3.80	.0004	.0162	.45	.0030	–
445	July 29	July 30	Slight.	Sli't, brown.	0.20	4.45	1.50	2.95	.0000	.0180	.46	.0000	–
642	Aug. 30	Aug. 30	Slight.	Very slight.	0.35	4.15	1.15	3.00	.0002	.0210	.46	.0030	–
643	Aug. 30	Aug. 30	Slight.	None.	0.25	4.25	1.27	2.98	.0002	.0209	.49	.0000	–
875	Oct. 3	Oct. 4	Distinct.	Sli't, brown.	0.20	4.30	1.32	2.98	.0000	.0242	.49	.0040	–
1090	Nov. 2	Nov. 2	Slight.	Sli't, brown.	0.20	4.10	1.45	2.65	.0000	.0250 .0244	.48	.0050	–
1321	Dec. 5	Dec. 6	Very slight.	Sli't, brown.	0.20	3.85	1.50	2.35	.0000	.0223	.45	.0000	–
	1888.												
1528	Jan. 3	Jan. 4	Slight.	Sli't, white.	0.20	4.30	1.15	3.15	.0000	.0192	.44	.0100	.0000
1735	Feb. 2	Feb. 3	Slight.	Slight.	0.40	4.30	1.40	2.90	.0000	.0281	.50	.0080	.0000
1945	Mar. 3	Mar. 5	Very slight.	Very slight.	0.30	4.10	0.95	3.15	.0022	.0180	.48	.0080	.0000
2150	Apr. 3	Apr. 4	Slight.	Very slight, white.	0.15	4.20	1.15	3.05	.0002	.0233	.45	.0050	.0001
2346	May 2	May 3	Slight.	Sli't, white.	0.25	4.15	1.60	2.55	.0000	.0218	.43	.0050	.0001
2549	June 4	June 6	Very slight.	Sli't, white.	0.30	4.25	1.25	3.00	.0004	.0218 .0216	.40	.0020	.0000
2710	July 2	July 5	Slight.	Slight.	0.20	3.85	1.45	2.40	.0026	.0204 .0198	.43	.0080	.0001
2858	July 31	Aug. 1	Slight.	None.	0.20	4.00	1.10	2.90	.0002	.0280 .0216	.45	.0000	.0000
3076	Sept. 5	Sept. 6	Slight.	Very slight.	0.10	3.65	1.20	2.45	.0000	.0222 .0174	.40	.0050	.0000
3309	Oct. 3	Oct. 4	Distinct.	Slight.	0.10	3.80	1.20	2.60	.0020	.0218 .0188	.39	.0030	.0002

Chemical Examination of Water from Spot Pond in Stoneham — Concluded.

Number.	Date of Collection.	Date of Exam-ination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albu-minoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
3493	Nov. 1	Nov. 2	Slight.	Very slight.	0.15	3.60	1.05	2.55	.0004	.0250 .0206	.41	.0060	.0001
3647	Dec. 4	Dec. 5	Slight.	Very slight.	0.25	3.60	1.35	2.25	.0004	.0204 .0180	.45	.0050	.0002
	1889.												
3824	Jan. 3	Jan. 4	Slight.	Very slight.	0.30	3.60	1.05	2.55	.0010	.0264 .0184	.47	.0070	.0004
3981	Feb. 6	Feb. 7	Very slight.	Slight.	0.20	3.70	1.35	2.35	.0006	.0194 .0188	.42	.0100	.0001
4232	Mar. 6	Mar. 7	Slight.	Very slight.	0.20	3.60	1.20	2.40	.0030	.0192 .0176	.46	.0070	.0004
4478	Apr. 8	Apr. 9	Slight.	Slight.	0.30	3.45	0.90	2.55	.0010	.0214 .0182	.44	.0050	.0002
4628	May 8	May 8	Slight.	Sli't, white.	0.35	3.35	1.35	2.00	.0020	.0230 .0206	.43	.0030	.0001
Av.	....	....	....	....	0.24	4.30	1.24	3.06	.0007	.0216	.45	.0044	.0001

Hardness in May, 1888, 1.8; in December, 1888, 1.5. Odor from June, 1887, to June, 1888, generally disagreeable; since June, 1888, vegetable and occasionally mouldy. —— Samples Nos. 9 and 245 were collected from a faucet in Oak Grove Station, Malden. Nos. 226 and 440 were collected from a faucet in Melrose pumping station. Nos. 442 and 643 were collected from a faucet in the Boston & Maine Railroad Station, Malden. Nos 10, 217, 445, 642, 875, 1090, 1321, 1528, 1735, 1945, 2150 and 2346 were collected from a faucet in a house in Medford on the line of the main pipe one and one-half miles from the pond. The remaining samples were collected from Spot Pond near the Malden pumping station.

Microscopical Examination.

	1888. June.	1888. July.	1888. July.	1888. Sept.	1888. Oct.	1888. Nov.	1888. Dec.	1889. Jan.	1889. Feb.	1889. Mar.	1889. Apr.	1889. May.
1. Blue-green Algæ, ...	0.0	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	1.3	pr.	0.9	0.9	pr.	7.1	5.1	0.1	0.3	0.3	1.0	0.2
3. Fungi, ...	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, ...	pr.	0.1	2.9	1.5	0.0	0.9	0.3	0.1	pr.	0.6	0.2	0.1

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Melosira*, *Tabellaria*. 3. Schizomycetes. 4. Protozoa, *Peridinium;* Rotifera; Entomostraca.

Table Showing Heights of Water in Spot Pond at the Times when Samples of Water were collected for Analysis.

NOTE.—Heights are in feet above or below high-water mark. The sign "+" indicates "above high water." The sign "—" indicates "below high water."

DATE.	Height of Water.	DATE.	Height of Water.
1887.		**1888.**	
May 24,	—0.28	June 4,	—0.04
June 29,	—0.95	July 2,	—0.96
July 2,	—1.05	July 31,	—2.08
July 29,	—1.41	September 5,	—2.75
August 30,	—1.83	October 3,	—2.17
October 3,	—2.61	November 1,	—1.56
November 2,	—3.14	December 4,	+0.12
December 5,	—3.44	**1889.**	
1888.		January 3,	+0.04
January 3,	—2.79	February 6,	0.00
February 2,	—3.00	March 6,	+0.04
March 3,	—2.08	April 8,	—0.04
April 3,	0.00	May 8,	—0.08
May 2,	—0.04		

Chemical Examination of Water from Tubular Wells at Webster Park, Malden.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
a	Nov. 12	Nov. 12	None.	None.	0.0	16.80	–	–	.0000	.0004	2.21	.3000	–
b	Dec. 20	Dec. 22	None.	None.	0.0	18.70	–	–	.0000	.0000	2.18	.5000	–
c	Dec. 28	Dec. 28	None.	None.	0.0	15.80	–	–	.0000	.0024	2.20	.5200	–
	1888.												
d	Jan. 4	Jan. 5	None.	None.	0.0	16.60	–	–	.0004	.0000	2.14	.4500	–
e	Jan. 12	Jan. 12	None.	None.	0.0	15.80	–	–	.0000	.0008	2.10	.6000	–
f	Jan. 18	Jan. 19	None.	None.	0.0	14.50	–	–	.0000	.0006	2.24	.3000	–
g	Jan. 25	Jan. 26	None.	None.	0.0	15.00	–	–	.0000	.0000	2.14	.4800	–
h	Feb. 2	Feb. 2	None.	None.	0.0	16.40	–	–	.0000	.0000	2.14	.4800	–
i	Feb. 9	Feb. 9	None.	None.	0.0	16.00	–	–	.0000	.0004	2.08	.4800	–
j	Feb. 15	Feb. 15	None.	None.	0.0	16.80	–	–	.0000	.0014	2.16	.4850	–
k	Mar. 2	Mar. 2	None.	None.	0.0	16.70	–	–	.0000	.0000	2.10	.5000	–

Chemical Examination of Water from Tubular Wells at Webster Park, Malden — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
l	Mar. 9	Mar. 9	None.	None.	0.0	17.40	–	–	.0000	.0000	2.14	.4800	–
m	Mar. 15	Mar. 15	None.	None.	0.0	15.80	–	–	.0000	.0004	2.09	.5000	–
3469	Oct. 30	Oct. 31	None.	None.	0.0	21.30	–	–	.0000	.0000	2.81	.6000	–
Av.	....	....	....	....	0.0	16.69	–	–	.0000	.0005	2.20	.4768	–

Hardness, average of b, c and m, 6.4. Odor, none.——These samples, with the exception of No. 3469, were collected while pumping from 12 trial wells during a time when a test of the yield of the wells was being made. A preliminary test was made Nov. 8 to Nov. 14, 1887, during which time 630,578 gallons in all were pumped from the wells. The final test was begun on Dec. 17, 1887, and ended March 16, 1888, during which time the average daily quantity of water pumped from the wells was 846,945 gallons. No. 3469 was collected from one of the trial wells several months after pumping was discontinued.

Microscopical Examination.

October, 1888. No organisms.

Chemical Examination of Water from a Flowing Tubular Well near Webster Park, in Malden.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
n	Nov. 5	Nov. 5	None.	None.	0.0	14.80	–	–	.0000	.0000	1.74	.5000	–
p	Nov. 21	Nov. 21	None.	None.	0.0	13.70	–	–	.0004	.0020	1.74	.3500	–
	1888.												
3470	Oct. 30	Oct. 31	None.	None.	0.0	14.70	–	–	.0000	.0002	1.33	.7500	–
Av.	....	....	....	....	0.0	14.40	–	–	.0001	.0007	1.60	.5333	–

The samples were collected from Eaton's flowing well in the vicinity of Webster Park.

Microscopical Examination.

October, 1888. No organisms.

WATER SUPPLY OF MANSFIELD WATER SUPPLY DISTRICT, MANSFIELD.

Description of Works. — Population of the town of Mansfield in 1885, 2,939. The works are owned by the district. Water was introduced in 1888. The average daily consumption for the first seven months of 1889 was 104,108 gallons, much of the water being used by the Old Colony Railroad. The source of supply is a large well located in the immediate vicinity of some large springs known as the Cate Springs, near the Canoe River in Mansfield. The well is 25 feet in diameter and 20 feet deep, lined with brick laid in cement, and roofed over to exclude the light. Pumps force the water from the well to an open iron tank 20 feet in diameter and 103 feet high. Distributing mains are of cast iron and service pipes of enameled iron and of lead.

Chemical Examination of Water from the Well of the Mansfield Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
1882	Feb. 23	Feb. 23	None.	Very slight.	0.0	2.65	–	–	.0000	.0030	.28	.0050	.0000
3628	Nov. 30	Dec. 1	None.	None.	0.0	2.70	–	–	.0000	.0014	.24	.0080	.0000
3737	Dec. 18	Dec. 19	None.	None.	0.0	2.90	–	–	.0000	.0010	.25	.0120	.0000
	1889.												
3852	Jan. 15	Jan. 16	None.	None.	0.0	2.65	–	–	.0000	.0000	.25	.0080	.0000
Av.	....	....	....	....	0.0	2.73	–	–	.0000	.0014	.26	.0083	.0000

Odor, none. —— Sample No. 1882 was collected from the Cate Springs before the well of the Mansfield Water Works was built. Samples Nos. 3628 and 3737 were collected from a faucet at the pumping station while pumping. No. 3852 was collected from a faucet in the village.

Microscopical Examination.

	1888. Nov.	1888. Dec.	1889. Jan.
1. Blue-green Algæ,	0.0	0.0	0.0
2. Other Algæ,	0.0	0.0	pr.
3. Fungi,	0.0	0.0	0.0
4. Animal Forms,	0.0	0.0	0.0

Groups and principal genera of organisms observed: 2. Diatomaceæ.

WATER SUPPLY OF MARBLEHEAD.

Description of Works.—Population in 1885, 7,517. The distributing system is owned by the town. Water is at present supplied by the Marblehead Water Company of Swampscott. The town of Marblehead has made investigations with reference to securing an independent supply, and has examined various sources, among others a ground water within the limits of the city of Salem, an analysis of which is here given. For a description of the works of the Marblehead Water Company and analyses of the water, see *Swampscott*.

Chemical Examination of Water from a Tubular Well in Salem.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
3604	Nov. 23	Nov. 24	None.	None.	0.0	9.65	–	–	.0000	.0008	1.25	.1250	.0000

Odor, none.—The sample was collected from a flowing tubular well in Salem near the boundary between Marblehead and Salem.

Microscopical Examination.

No organisms.

WATER SUPPLY OF MARLBOROUGH.

Description of Works. — Population in 1885, 10,941. The works are owned by the town. Water was introduced in 1883. The average daily consumption in 1888 was 292,400 gallons. The source of supply is Lake Williams in Marlborough. The area of the lake is 72 acres and its capacity is 270,000,000 gallons. There is little shallow flowage and the general depth of the lake is from ten to twenty-six feet. The bottom is muddy. The watershed of about 288 acres, exclusive of the area of the pond, is generally farming and pasture land. The town has begun to encroach upon the watershed of the pond, and the population at present within the watershed is estimated to be about 200 people. Water is pumped from the lake to an open distributing reservoir 275 feet long, 230 feet wide and 15 feet deep when full. The bottom of the reservoir is of clay covered with six inches of gravel, and the slopes are paved. Water is delivered to the reservoir on one side and is drawn out at the other. During the summer season all water pumped passes through the distributing reservoir. Distributing mains are of cast iron and service pipes are of wrought iron lined with cement.

Chemical Examination of Water from Lake Williams, Marlborough.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1887.												
183	June 23	June 24	Slight.	Very slight.	0.05	4.05	1.05	3.00	.0026	.0205	.46	.0000	–
392	July 22	July 23	Sli't, milky.	None.	0.20	4.40	0.87	3.53	.0020	.0208	.42	.0000	–
654	Aug. 30	Sept. 1	None.	None.	0.05	4.07	0.50	3.57	.0005	.0182	.42	.0000	–
996	Oct. 20	Oct. 21	Very slight.	Very slight, white.	0.05	3.95	0.65	3.30	.0000	.0164	.46	.0070	–
1255	Nov. 26	Nov. 28	Very slight.	None.	0.10	4.10	0.25	3.85	.0006	.0144	.48	.0030	–
1476	Dec. 22	Dec. 23	Slight.	Very slight.	0.05	4.00	0.60	3.40	.0002	.0164	.47	.0000	–
	1888.												
1738	Feb. 2	Feb. 3	Slight.	None.	0.05	4.15	0.90	3.25	.0000	.0183	.50	.0090	.0001
1892	Feb. 27	Feb. 28	Very slight.	None.	0.10	4.20	0.90	3.30	.0012	.0196	.49	.0070	.0001
2119	Mar. 29	Mar. 30	Decided.	Sli't, white.	0.10	4.05	0.75	3.30	.0018	.0214	.42	.0050	.0002
2253	Apr. 19	Apr. 20	Slight.	Very slight.	0.10	3.70	0.55	3.15	.0000	.0183	.40	.0080	.0001
2503	May 23	May 24	Slight.	Very slight.	0.10	3.60	0.65	2.95	.0002	.0150	.41	.0050	.0000
2686	June 28	June 29	Decided.	Sli't, white.	0.00	3.90	0.55	3.35	.0000	.0246 .0156	.44	.0050	.0000
2784	July 17	July 18	Distinct.	Sli't, white.	0.10	4.05	1.20	2.85	.0000	.0244 .0172	.40	.0000	.0000
3006	Aug. 21	Aug. 22	Slight.	Very slight.	0.05	4.40	1.15	3.25	.0022	.0208 .0152	.42	.0000	.0002
3285	Sept. 29	Oct. 1	Very slight.	Very slight.	0.00	3.90	1.00	2.90	.0000	.0224 .0198	.44	.0030	.0002
3461	Oct. 27	Oct. 29	Slight.	Sli't, earthy and fibr'us.	0.00	4.15	1.10	3.05	.0002	.0242 .0188	.48	.0020	.0000
3621	Nov. 29	Nov. 30	Sli't, milky.	Sli't, white.	0.05	3.95	1.25	2.70	.0002	.0208 .0186	.44	.0080	.0000
3761	Dec. 20	Dec. 20	Decided.	Slight.	0.00	3.80	0.95	2.85	.0002	.0158 .0134	.45	.0130	.0005
	1889.												
3902	Jan. 23	Jan. 23	Slight.	Sli't, light green.	0.05	3.75	1.25	2.50	.0002	.0142 .0134	.47	.0220	.0000
4053	Feb. 20	Feb. 21	Slight.	Sli't, green.	0.05	4.05	0.70	3.35	.0000	.0162 .0126	.45	.0100	.0003
4356	Mar. 20	Mar. 21	Slight.	Very slight.	0.05	3.85	1.00	2.85	.0000	.0234 .0180	.45	.0100	.0003
4534	Apr. 18	Apr. 19	Distinct.	Sli't, white.	0.00	4.00	1.25	2.75	.0004	.0266 .0198	.47	.0020	.0000
4678	May 16	May 17	Very slight.	Very slight.	0.00	3.95	0.95	3.00	.0020	.0170 .0164	.49	.0040	.0000
Av.	....	....	....	....	0.06	4.02	0.70	3.32	.0006	.0196	.45	.0053	.0001

Hardness in May, 1888, 2.3. Odor, faintly vegetable, occasionally mouldy and disagreeable. —— The samples were collected from a faucet at the pumping station, while pumping, with the exception of Nos. 2686 to 4053 inclusive, which were collected from the lake. There were heavy rains just previous to the collection of Nos. 392 and 2119. At the time of the collection of No. 996 the water in the lake was low. The height of the water in the lake varied only about 2.7 feet during the time samples were collected. The lowest point reached was in October, 1887, which was over a foot lower than the lowest point reached in 1888.

Microscopical Examination.

	1888.							1889.				
	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ, .	0.0	0.5	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
2. Other Algæ, . .	0.4	1.1	1.4	pr.	160.7	11.1	18.4	5.0	52.0	4.4	4.0	1.1
3. Fungi, ...	0.7	pr.	pr.	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, . .	0.0	0.0	pr.	pr.	24.0	0.3	0.0	0.0	0.2	0.2	0.6	0.8

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Asterionella*, *Stephanodiscus*, *Tabellaria*. 3. Schizomycetes. 4. Protozoa, *Dinobryon*, *Hydromorum;* Rotifera; Entomostraca.

Chemical Examination of Water from the Distributing Reservoir of the Marlborough Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
182	June 22	June 24	Slight.	Very slight.	0.05	4.60	1.00	3.60	.0017	.0214	.49	.0000	–
393	July 22	July 23	Very slight.	Sli't, brown.	0.10	4.12	0.35	3.77	.0015	.0209	.39	.0000	–
655	Aug. 30	Sept. 1	Very slight.	None.	0.00	4.27	0.50	3.77	.0002	.0179	.45	.0000	–
814	Sept. 19	Sept. 20	Very slight.	Very slight.	0.00	4.25	0.60	3.65	.0005	.0206	.43	.0030	–
997	Oct. 20	Oct. 21	Slight.	Very slight, white.	0.00	4.25	0.45	3.80	.0000	.0184	.47	.0000	–
1256	Nov. 26	Nov. 28	Very slight.	Very slight, white.	0.05	4.00	0.55	3.45	.0014	.0155	.55	.0030	–
1477	Dec. 22	Dec. 23	Slight.	Sli't, white.	0.00	4.25	1.00	3.25	.0000	.0174	.49	.0010	–
	1888.												
1739	Feb. 2	Feb. 3	Very slight.	None.	0.00	4.25	0.70	3.55	.0002	.0170	.53	.0060	.0001
1893	Feb. 27	Feb. 28	Slight.	Very slight.	0.10	4.40	0.95	3.45	.0012	.0172	.51	.0050	.0001
2120	Mar. 29	Mar. 30	Distinct.	Sli't, brown.	0.05	3.90	0.75	3.15	.0026	.0194	.44	.0060	.0002
2254	Apr. 19	Apr. 20	Slight.	Sli't, white.	0.05	3.70	0.55	3.15	.0002	.0176	.40	.0100	.0001
2504	May 23	May 24	Slight.	Slight.	0.10	3.65	0.70	2.95	.0002	.0134	.42	.0040	.0000
Av.	....	....	....	....	0.04	4.14	0.68	3.46	.0008	.0181	.46	.0032	.0001

Hardness in May, 1888, 2.2. Odor, faintly vegetable, occasionally mouldy.——The samples were collected from a faucet at a house near the reservoir. No water had been pumped into the reservoir for six days previous to the collection of No. 997.

Microscopical Examination.

	1888.		
	March.	April.	May.
1. Blue-green Algæ,	0.0	0.0	0.0
2. Other Algæ,	0.0	pr.	pr.
3. Fungi,	0.0	0.0	0.0
4. Animal Forms,	pr.	pr.	0.0

Groups and principal genera of organisms observed: 2. Palmellaceæ; Diatomaceæ. 4. Protozoa.

WATER SUPPLY OF MAYNARD.

Description of Works. — Population in 1885, 2,703. The works are owned by the town. Water was introduced in December, 1889. The source of supply is White Pond in Hudson and Stow. The area of White Pond is 58½ acres. The watershed is flat, sandy land, and its limits are indefinite; its area, exclusive of the pond, is estimated to be 125 acres. Water is drawn from the pond by means of a long conduit of vitrified pipe to a pumping station, from which it is forced by pumps to a distributing reservoir and to the village. The distributing reservoir is circular in shape, 120 feet in diameter, and 20 feet in depth at high water. The bottom is of concrete and the slopes are paved and cemented. Distributing mains are of cast iron; service pipes are of wrought iron lined with cement.

Chemical Examination of Water from White Pond.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1887.												
769	Sept. 14	Sept. 15	Distinct.	Sli't, earthy.	0.0	1.70	0.65	1.05	.0001	.0110	.20	.0130	–

Odor, very faint or none. —— The sample was collected from the pond 300 feet from shore and 6 inches beneath the surface.

Water Supply of Medford.

Description of Works. — Population in 1885, 9,042. The works are owned by the town and were built in 1870. There were 1,998 families supplied in 1888. The source of supply is Spot Pond in Stoneham, from which water is generally distributed by gravity. Distributing mains are of wrought iron lined with cement. Service pipes are of wrought iron lined with cement and of galvanized iron. A small reservoir was built at the pond in 1883, into which water is pumped to supply the town when the water in the pond is below the top of the inlet pipe. For a description of Spot Pond and analyses of its water, see *Malden*.

Chemical Examination of Water from Saville's Ice Pond in Medford.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Exam-ination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albu-minoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
4698	May 20	May 21	Slight.	Sli't, reddish brown.	0.60	4.35	1.55	2.80	.0026	.0304 .0268	.32	.0030	.0001

Odor, vegetable and mouldy. —— The sample was collected from the pond. This examination was made with reference to a proposed additional water supply for Medford.

Microscopical Examination.

May, 1889. 1. Blue-green algæ, 0.0; 2. Other algæ, 1.7; 3. Fungi, pr.; 4. Animal forms, 0.2.

Groups and principal genera of organisms observed: 2. Palmellaceæ; Zoosporeæ; Diatomaceæ. 3. Schizomycetes. 4. Protozoa; Rotifera.

Chemical Examination of Water from Lower Mystic Lake, a Tidal Basin, in Medford.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Exam-ination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albu-minoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
428	July 27	July 29	Very slight.	Con., dark.	–	241.50	32.40	209.10	.0578	.0506	127.0	–	–
429	July 27	July 29	Very slight.	Con., dark.	–	249.40	32.70	216.70	.0470	.0481	119.0	–	–

Sample No. 428 was collected from about the middle of the upper half of the lake. No. 429 was collected from the stream at the first bridge below the lake. The tide was running out at the time the sample was collected.

WATER SUPPLY OF MELROSE.

Description of Works. — Population in 1885, 6,101. The works are owned by the town and were built in 1870. The average daily consumption during a part of 1887 is said to have been 430,000 gallons. The source of supply is Spot Pond in Stoneham. Water was originally distributed by gravity, but in 1886 a distributing reservoir was built and all water is now pumped. The distributing reservoir is 94 feet square on the bottom and 145 feet square at the top. Its depth is 17 feet and its capacity is 1,500,000 gallons. Distributing mains and service pipes are of wrought iron lined with cement. For a description of Spot Pond and analyses of its water, see *Malden*. The analyses given below were from a pond in the village of Melrose, which has no connection with the water supply of the town.

Chemical Examination of Water from Ell Pond in Melrose.

[Parts per 100,000.]

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.	Chlorine.	Nitrates.	Nitrites.
	1888.												
3441	Oct. 25	Oct. 26	Distinct.	Con.,e'rthy.	0.60	8.00	2.10	5.90	.0180	.0370 .0224	1.00	.0450	.0012
	1889.												
4102	Feb. 23	Feb. 25	Decided.	H'vy,earthy and floc't.	0.20	7.40	2.05	5.35	.0240	.0202 .0130	0.94	.0650	.0009

Odor, faintly mouldy.——The samples were collected from the pond near the outlet.

WATER SUPPLY OF METHUEN.

Description of Works. — Population in 1885, 4,507. The works are merely an extension of the water works system of the city of Lawrence, into a portion of the town. *See Lawrence.*

WATER SUPPLY OF MIDDLEBOROUGH FIRE DISTRICT, MIDDLEBOROUGH.

Description of Works. — Population of the town of Middleborough in 1885, 5,163. The population of the fire district was estimated to be about 2,800 in 1887. The works are owned by the Fire District. Water was introduced in 1885. The average daily consumption in 1888 was about 90,000 gallons. The source of supply is a well near the Nemasket River above the village of Middleborough. The well is 26 feet in diameter and 22 feet deep, built of stone, laid dry, with a lining of brick masonry 12 inches in thickness.

The well is roofed over to exclude light. Pumps force the water to a covered iron tank situated on the opposite side of the village from the well, so that while pumping the supply of the village comes from the well. The tank is 20 feet in diameter and 103 feet high, and by an arrangement of valves water enters the tank at the top and flows out of it at the bottom. Distributing mains are of cast iron. Service pipes are of wrought iron lined with cement.

Chemical Examination of Water from the Well of the Middleborough Fire District.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Exam-ination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albu-minoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
94	June 14	June 15	None.	None.	0.0	8.67	–	–	.0006	.0018	1.18	.1560	–
309	July 11	July 12	None.	None.	0.0	8.40	–	–	.0006	.0019	0.90	.0850	–
527	Aug. 11	Aug. 12	None.	None.	0.0	7.95	–	–	.0002	.0028	0.90	.1630	–
741	Sept. 12	Sept. 13	None.	None.	0.0	8.72	–	–	.0007	.0022	0.94	.1140	–
940	Oct. 12	Oct. 13	None.	None.	0.0	7.85	–	–	.0000	.0014	0.85	.1950	–
1146	Nov. 10	Nov. 11	Very slight.	None.	0.0	8.35	–	–	.0000	.0016	0.91	.1500	–
1395	Dec. 13	Dec. 14	Slight.	Very slight, earthy.	0.0	8.80	–	–	.0004	.0018	1.02	.2000	–
	1888.												
1670	Jan. 23	Jan. 24	None.	None.	0.0	9.40	–	–	.0005	.0018	1.06	.2250	–
1872	Feb. 20	Feb. 21	None.	Very slight.	0.0	8.75	–	–	.0005	.0029	1.10	.1900	.0002
2083	Mar. 21	Mar. 22	None.	None.	0.0	8.75	–	–	.0000	.0020	0.98	.1700	.0001
2289	Apr. 23	Apr. 24	None.	None.	0.0	8.80	–	–	.0000	.0016	0.97	.1300	.0001
2474	May 21	May 22	Very slight.	None.	0.0	9.00	–	–	.0000	.0014	0.95	.1500	.0001
2629	June 19	June 20	None.	None.	0.0	8.90	–	–	.0000	.0010	0.97	.1300	.0001
2841	July 23	July 26	Very slight.	Very slight.	0.0	8.15	–	–	.0000	.0032	0.87	.1500	.0001
3017	Aug. 22	Aug. 23	Slight.	Very slight.	0.0	7.65	–	–	.0000	.0056	0.84	.0730	.0001
3267	Sept. 26	Sept. 27	None.	None.	0.0	8.40	–	–	.0000	.0024	0.90	.1000	.0001
3436	Oct. 24	Oct. 25	None.	None.	0.0	8.35	–	–	.0000	.0028	0.98	.1600	.0001
3589	Nov. 22	Nov. 23	None.	None.	0.0	8.75	–	–	.0000	.0030	0.95	.1500	.0001
3754	Dec. 19	Dec. 20	Very slight.	Very slight.	0.0	9.20	–	–	.0000	.0018	0.99	.1650	.0001
	1889.												
3915	Jan. 23	Jan. 24	None.	None.	0.0	8.50	–	–	.0000	.0012	0.97	.1750	.0002
4157	Feb. 27	Feb. 28	None.	None.	0.0	8.55	–	–	.0000	.0040	0.99	.3100	.0000
4427	Mar. 28	Mar. 29	None.	None.	0.0	8.50	–	–	.0000	.0018	0.96	.1550	.0001
4575	Apr. 25	Apr. 26	Very slight.	None.	0.0	9.30	–	–	.0008	.0022	1.01	.1550	.0001
4717	May 22	May 23	None.	Very slight.	0.0	9.00	–	–	.0000	.0028	0.96	.0900	.0001
Av.	....	....	....	....	0.0	8.61	–	–	.0002	.0023	0.96	.1559	.0001

Hardness in May, 1888, 3.5. Odor, none.——The samples were collected from a faucet at the pumping station while pumping.

Microscopical Examination.

	1888.									1889.				
	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ,	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ,	0.0	0.0	0.0	0.0	0.0	pr.	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0
3. Fungi,	pr.	pr.	0.0	0.7	0.2	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms,	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Groups and principal genera of organisms observed: 2. Diatomaceæ. 3. Schizomycetes. 4. Protozoa.

Chemical Examination of Water from the Tank of the Middleborough Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
941	Oct. 12	Oct. 13	None.	None.	0.00	8.45	–	–	.0000	.0016	0.86	.1630	–
1147	Nov. 10	Nov. 11	None.	None.	0.00	8.35	–	–	.0000	.0014	0.90	.1500	–
1396	Dec. 13	Dec. 14	Very slight.	Very slight.	0.00	9.10	–	–	.0004	.0018	1.01	.2000	–
	1888.												
1671	Jan. 23	Jan. 24	Slight.	Sli't, brown.	0.05	9.65	–	–	.0000	.0020	1.08	.2000	.0001
1873	Feb. 20	Feb. 21	Very slight.	Very slight.	0.00	9.25	–	–	.0009	.0020	1.01	.1600	.0001
2084	Mar. 21	Mar. 22	Slight.	Very slight.	0.10	9.05	–	–	.0008	.0032	0.98	.1800	.0001
2290	Apr. 23	Apr. 24	Sl't, milky.	None.	0.05	9.25	–	–	.0016	.0032	1.01	.1500	.0002
2475	May 21	May 22	Very slight.	None.	0.00	9.30	–	–	.0000	.0016	0.97	.1700	.0001
2630	June 19	June 20	None.	None.	0.00	9.45	–	–	.0000	.0024	0.98	.2600	.0001
2842	July 23	July 26	None.	Very slight.	0.00	8.85	–	–	.0000	.0018	0.88	.1500	.0001
3018	Aug. 22	Aug. 23	None.	None.	0.00	7.90	–	–	.0000	.0044	0.80	.1100	.0001
3268	Sept. 26	Sept. 27	None.	None.	0.00	7.90	–	–	.0000	.0022	0.90	.1200	.0000
3437	Oct. 24	Oct. 25	Very slight.	None.	0.00	8.85	–	–	.0000	.0030	0.95	.1500	.0000
Av.	....	....	....	....	0.00	8.87	–	–	.0003	.0024	0.95	.1664	.0001

Hardness in May, 1888, 3.5. Odor, none. —— The samples were collected from a faucet about one hundred feet from the tank, with the exception of No. 2842, which was collected from a faucet at about the middle of the village, as the tank was being cleaned and painted at this time.

Microscopical Examination.

	1888.							
	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1. Blue-green Algæ,	pr.	0.0	0.0	0.0	pr.	0.0	0.0	0.0
2. Other Algæ,	0.0	pr.	pr.	pr.	0.0	0.0	0.0	0.0
3. Fungi,	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0
4. Animal Forms,	0.0	0.0	0.0	0.0	pr.	0.0	0.0	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Desmidiaceæ; Diatomaceæ. 3. Schizomycetes. 4. Nematoda.

Chemical Examination of Water from the Nemasket River above Middleborough.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
95	June 14	June 15	Very slight.	Sli't, brown.	0.60	3.47	2.05	1.42	.0005	.0200	.49	.0000	–
308	July 11	July 12	None.	None.	0.70	3.60	1.30	2.30	.0005	.0214	.39	.0000	–
526	Aug. 11	Aug. 12	None.	None.	0.35	3.10	1.30	1.80	.0002	.0170	.48	.0000	–
740	Sept. 12	Sept. 13	Slight.	Slight.	0.20	3.27	1.05	2.22	.0001	.0184	.47	.0000	–
939	Oct. 12	Oct. 13	Very slight.	Very slight.	0.50	3.75	1.10	2.65	.0004	.0205	.51	.0090	–
1145	Nov. 10	Nov. 11	Very slight.	Very slight.	0.10	3.40	1.30	2.10	.0006	.0130	.47	.0030	–
1394	Dec. 13	Dec. 14	Very slight.	Slight.	0.50	4.45	1.70	2.75	.0000	.0210	.52	.0020	–
	1888.												
1669	Jan. 23	Jan. 24	Very slight.	Very slight.	0.20	3.30	1.20	2.10	.0000	.0172	.43	.0050	.0000
1871	Feb. 20	Feb. 21	Very slight.	Very slight.	0.20	3.50	1.40	2.10	.0002	.0189	.49	.0100	.0000
2082	Mar. 21	Mar. 22	Distinct.	Slight.	0.40	3.50	1.45	2.05	.0006	.0211	.45	.0050	.0000
2288	Apr. 23	Apr. 24	Very slight.	Very slight.	0.50	3.10	0.95	2.15	.0004	.0198	.44	.0030	.0001
2473	May 21	May 22	Very slight.	Very slight.	0.50	3.80	1.70	2.10	.0000	.0194	.41	.0050	.0000
2628	June 19	June 20	Very slight.	Very slight.	0.70	3.80	1.60	2.20	.0000	.0226 .0224	.43	.0030	.0001
2840	July 23	July 26	None.	Very slight.	1.10	4.85	2.15	2.70	.0012	.0314 .0270	.41	.0060	.0003
3019	Aug. 22	Aug. 23	Slight.	Slight.	0.80	3.80	1.60	2.20	.0000	.0252 .0226	.34	.0020	.0000
3266	Sept. 26	Sept. 27	Very slight.	Slight.	0.50	3.40	1.50	1.90	.0000	.0184 .0178	.32	.0030	.0002
3435	Oct. 24	Oct. 25	Slight.	Very slight.	0.60	3.45	1.55	1.90	.0002	.0196 .0184	.42	.0030	.0001
3588	Nov. 22	Nov. 23	Very slight	Slight.	0.70	3.55	1.90	1.65	.0002	.0208 .0168	.42	.0050	.0002
3753	Dec. 19	Dec. 20	Very slight.	Slight.	0.70	3.60	1.50	2.10	.0000	.0178 .0160	.43	.0030	.0002
	1889.												
3914	Jan. 23	Jan. 24	Slight.	Slight.	0.70	3.50	1.55	1.95	.0004	.0186 .0162	.40	.0060	.0002
4156	Feb. 27	Feb. 28	Very slight.	Very slight.	0.70	3.60	1.70	1.90	.0000	.0192 .0164	.44	.0020	.0001
4428	Mar. 28	Mar. 29	Slight.	Slight.	0.70	3.25	1.40	1.85	.0000	.0208 .0172	.42	.0050	.0001
4574	Apr. 25	Apr. 26	Slight.	Slight.	0.80	3.50	1.70	1.80	.0002	.0208 .0192	.41	.0060	.0002
4716	May 22	May 23	Very slight.	Slight.	0.80	3.75	1.75	2.00	.0026	.0258 .0228	.38	.0030	.0002
Av.	....	....	....	....	0.56	3.52	1.38	2.14	.0003	.0204	.43	.0037	.0001

Hardness in May, 1888, 0.8. Odor, distinctly vegetable.—— The samples were collected from the river near the pumping station of the Middleborough Fire District, at a depth of from 1½ to 2½ feet beneath the surface of the water. The water in the river was high on account of heavy rains at the time of collecting samples numbered 1871, 2082, 3019, 3266, 3435 and 3914. This river rises in Assawompset Pond, 2½ miles from the point where the samples were collected, and consequently has the characteristics of the water of the pond.

Microscopical Examination.

	1888.							1889.				
	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ,	pr.	0.0	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	pr.
2. Other Algæ,	0.2	0.2	0.2	2.1	pr.	1.1	0.1	0.3	10.8	15.1	4.0	1.4
3. Fungi,	0.1	0.6	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms,	pr.	0.0	0.0	0.0	0.0	0.1	pr.	0.1	0.5	1.4	0.0	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ, *Ulothrix;* Desmidiaceæ, Diatomaceæ, *Asterionella*, *Synedra*, *Tabellaria;* Zygnemaceæ. 3. Schizomycetes. 4. Protozoa, *Peridinium;* Spongiaria; Rotifera.

Water Supply of Middleton.

Description of Works. — Population in 1885, 899. The works are owned and operated by the town of Danvers and form a part of the Danvers system. *See Danvers.*

Water Supply of Milford and Hopedale. — Milford Water Company.

Description of Works. — Population of Milford (including Hopedale) in 1885, 9,343. The town of Hopedale was set off from Milford in 1886. The population of Hopedale in 1887 was estimated to be about 1,200. The works are owned by the Milford Water Company and were built in 1881. The average daily consumption in 1887 was 450,000 gallons. The sources of supply are three wells in Milford on the right bank of Charles River above the town, supplemented in emergencies by water from the river. The wells are each 30 feet in depth and 14, 21 and 23 feet respectively in diameter; they are connected and are roofed over to exclude light. There is a direct connection between the well nearest the pumping station and the river. The company also owns a storage reservoir on the river above the wells. This reservoir is 90 acres in area and its maximum depth is about 25 feet. Its drainage area is generally woodland and is uninhabited. The water in the river beside the wells is kept at a constant height by means of a small dam. Water is pumped directly into the mains, no reservoir or tank being used. Distributing mains are of cast iron. Service pipes are of lead.

WATER SUPPLY OF THE STATE PRIMARY SCHOOL, MONSON.

This is a supply to a public institution. The main source of supply is a small storage reservoir formed by a dam across a ravine on the side of a hill about half a mile west of the school.

Chemical Examination of Water from the Storage Reservoir of the State Primary School at Monson.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
2836	July 24	July 25	Distinct.	Slight, earthy.	0.05	3.25	0.70	2.55	.0000	.0248 .0124	.17	.0040	.0002
2988	Aug. 20	Aug. 21	Distinct.	Much, brown.	0.15	3.95	1.00	2.95	.0088	.0298 .0160	.20	.0050	.0006
3255	Sept. 24	Sept. 25	Slight.	Heavy, brown.	0.20	3.90	1.10	2.80	.0030	.0750 .0144	.17	.0180	.0004
3782	Dec. 21	Dec. 22	Slight.	Slight.	0.05	2.70	0.75	1.95	.0000	.0122 .0080	.14	.0150	.0002
Av.	....	....	....	....	0.11	3.45	0.89	2.56	.0030	.0355 .0127	.17	.0105	.0004

Odor, very faint or none.—— The samples were collected from a faucet in the school buildings.

Microscopical Examination.

	1888. July.	1888. Aug.	1888. Sept.	1888. Dec.
1. Blue-green Algæ,	0.0	0.0	0.0	0.0
2. Other Algæ,	333.3	1502.1	1600.8	pr.
3. Fungi,	0.0	0.0	0.0	pr.
4. Animal Forms,	0.1	pr.	pr.	0.0

Groups and principal genera of organisms observed: 2. Zoosporeæ, *Scenedesmus;* Diatomaceæ, *Synedra*. 3. Schizomycetes. 4. Rotifera; Entomostraca. Nearly all of the organisms grouped under the head of "Other algæ" were *Synedra*.

WATER SUPPLY OF TURNER'S FALLS FIRE DISTRICT, MONTAGUE.

Description of Works. — Population of the town of Montague in 1885, 5,629. The works are owned by the Fire District. Water was introduced in 1887. The average daily consumption in 1888 was about 228,000 gallons. The source of supply is Lake Pleasant, located in a sandy plain in Montague. Its area is 45 acres and its maximum depth is 40 feet. The bottom is of gravel. Water is drawn from the lake at a point 170 feet from the shore and at a depth of about 20 feet, and is forced to the distributing reservoir and to the village. The distributing reservoir is located on a short

branch from the main pipe about midway between the lake and the village. The reservoir is shaped like an inverted frustum of a cone. Its diameter at high water is 149 feet and at the bottom is 110 feet. Its depth when full is 13 feet and its capacity 1,270,000 gallons. The bottom of the reservoir is of concrete and the slopes are paved. Distributing mains are of cast iron. Service pipes are of wrought iron.

Chemical Examination of Water from Lake Pleasant, Montague.

[Parts per 100,000.]

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.
	1887.												
71	June 9	June 11	None.	None.	0.00	2.40	0.87	1.53	.0023	.0145	.08	.0000	–
281	July 7	July 8	Slight.	Sli't, brown.	0.00	3.40	0.90	2.50	.0008	.0100	.11	.0000	–
487	Aug. 5	Aug. 6	Slight.	Slight.	0.10	2.82	1.12	1.70	.0008	.0113	.16	.0000	–
719	Sept. 7	Sept. 9	Decided.	Sli't, brown.	0.05	2.60	0.55	2.05	.0003	.0099	.09	.0030	–
900	Oct. 6	Oct. 8	Very slight.	Very slight.	0.00	2.60	0.70	1.90	.0000	.0104	.07	.0000	–
1344	Dec. 5	Dec. 8	Distinct.	Sli't, white.	0.00	2.60	0.70	1.90	.0063	.0132	.11	.0010	–
	1888.												
1543	Jan. 5	Jan. 6	Slight.	Very slight.	0.00	2.95	0.70	2.25	.0064	.0120	.12	.0080	.0000
1836	Feb. 14	Feb. 15	Slight.	Slight.	0.00	2.35	0.55	1.80	.0083	.0096	.09	.0120	.0000
2039	Mar. 16	Mar. 19	Very slight.	None.	0.00	2.50	0.40	2.10	.0037	.0068	.09	0150	.0000
2217	Apr. 13	Apr. 14	Very slight.	None.	0.00	2.15	0.50	1.65	.0020	.0046	.09	.0180	.0002
2413	May 11	May 14	Very slight.	None.	0.00	2.35	0.40	1.95	.0024	.0046	.07	.0080	.0000
2776	July 11	July 14	Very slight.	Slight.	0.00	2.25	0.40	1.85	.0000	.0070 .0046	.07	.0020	.0000
2941	Aug. 15	Aug. 16	None.	Very slight.	0.00	2.35	0.50	1.85	.0000	.0072	.13	.0050	.0000
3213	Sept. 18	Sept. 19	Very slight.	None.	0.00	2.40	0.55	1.85	.0000	.0068 .0062	.11	.0030	.0000
3376	Oct. 15	Oct. 17	Very slight.	None.	0.00	2.10	0.40	1.70	.0002	.0064 .0042	.09	.0060	.0001
3594	Nov. 22	Nov. 23	Very slight.	None.	0.00	2.15	0.50	1.65	.0036	.0056 .0052	.08	.0100	.0001
3788	Dec. 19	Dec. 22	None.	None.	0.00	2.10	0.50	1.60	.0034	.0076 .0060	.09	.0060	.0001
	1889.												
3896	Jan. 21	Jan. 23	Very slight.	None.	0.00	1.95	0.35	1.60	.0000	.0052 .0034	.10	.0050	.0000
4134	Feb. 26	Feb. 27	Very slight.	Very slight.	0.03	2.40	0.45	1.95	.0016	.0058	.10	.0120	.0000
4418	Mar. 25	Mar. 28	None.	None.	0.00	2.45	0.50	1.95	.0014	.0040 .0038	.07	.0120	.0001
4581	Apr. 25	Apr. 27	None.	None.	0.00	2.05	0.20	1.85	.0008	.0082 .0066	.10	.0090	.0001
Av.	....	....	....	....	–	2.59	0.66	1.93	.0021	.0081	.10	.0064	–

Hardness in May, 1888, 1.2. Odor, very faintly vegetable, frequently none.—The samples were collected from the lake until March, 1888; the March sample and those following were collected from a faucet in the village. At the time of collecting No. 281 the lake was unusually high, and at the time of collecting No. 487 the lake was said to be the highest ever known.

Microscopical Examination.

	1888.						1889.			
	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
1. Blue-green Algæ,	0.0	0.0	0.0	0.0	0.0	–	0.0	0.0	0.0	0.0
2. Other Algæ,	1.1	0.2	0.1	0.3	7.2	–	0.1	0.2	pr.	2.1
3. Fungi,	0.2	0.0	0.0	0.0	0.0	–	0.0	0.0	0.0	0.0
4. Animal Forms,	0.0	0.0	pr.	0.0	0.0	–	0.4	pr.	0.2	pr.

Groups and principal genera of organisms observed: 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Melosira*. 3. Schizomycetes. 4. Protozoa.

Chemical Examination of Water from Green Pond, Montague.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1887.												
283	July 7	July 8	Slight.	None.	0.0	1.62	0.88	0.74	.0006	.0211	.08	.0000	–
488	Aug. 4	Aug. 6	Very slight.	Very slight.	0.0	1.70	0.85	0.85	.0002	.0151	.08	.0000	–

Odor, faintly vegetable. —— The samples were collected from the pond. The water was unusually high at the time the samples were collected on account of recent heavy rains.

Water Supply of Nahant.

Description of Works. — Population in 1885, 637. The distributing system is owned by the town. Water is supplied by the Marblehead Water Company of Swampscott. *See Swampscott.*

Water Supply of Nantucket. — Wannacomet Water Company.

Description of Works. — Population in 1885, 3,142. The works are owned by the Wannacomet Water Company and were built in 1878. The average daily consumption for 1888 was about 60,000 gallons. The source of supply is a small pond known as Wannacomet Pond situated very near the sea, a short distance west of the village. The surface of the pond is about 4 feet above ordinary high tide. The area of the pond is 8 acres, and its maximum depth is about 15 feet. The bottom is sandy near the shores and somewhat muddy in the middle; there is no shallow flowage. The drainage area is not large and is almost entirely pasture land. Pumps force the water from the pond to an open iron tank 24 feet in diameter and 15 feet in depth, which is supported on cast-iron posts 27 feet in height, making

the top of the tank 42 feet above the ground. Distributing mains are of cast iron. Service pipes are of lead and galvanized iron.

Frequently in the early fall the water of the pond acquires a disagreeable taste and odor. This trouble was very marked in 1884 and 1889. An examination of the water in the latter year showed the presence of large numbers of blue-green algæ. The grass which grows on the bottom of the pond has been kept cut beneath the surface with a view to improving the quality of the water.

The height of water in Wannacomet Pond during the time that samples of water were collected for analysis varied but one foot. The greatest variation of the height of the water in the pond is about 2½ feet.

Chemical Examination of Water from Wannacomet Pond, Nantucket.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1887.												
359	July 18	July 19	Very slight.	None.	0.05	6.70	1.22	5.48	.0003	.0166	2.19	.0030	–
549	Aug. 14	Aug. 16	Distinct.	Slight.	0.20	6.75	1.02	5.73	.0002	.0170	2.16	.0000	–
762	Sept. 13	Sept. 14	Decided.	Slight.	0.08	6.82	1.07	5.75	.0001	.0165	2.24	.0030	–
1190	Nov. 14	Nov. 16	Very slight.	Slight.	0.00	6.60	1.50	5.10	.0000	.0198	2.22	.0020	–
	1888.												
1589	Jan. 11	Jan. 14	–	–	–	–	–	–	.0000	.0156	–	–	–
1807	Feb. 12	Feb. 14	Very slight.	Very slight.	0.10	6.20	1.05	5.15	.0000	.0128	2.25	.0050	.0001
2043	Mar. 18	Mar. 20	Slight.	None.	0.00	5.95	0.80	5.15	.0000	.0152	2.10	.0060	.0001
2291	Apr. 23	Apr. 24	Very slight.	Slight.	0.05	5.85	0.95	4.90	.0006	.0138	2.06	.0050	.0001
2465	May 17	May 19	Slight.	None.	0.05	5.90	1.10	4.80	.0002	.0192	2.03	.0030	.0003
Av.	....	....	....	....	0.07	6.35	1.09	5.26	.0002	.0163	2.16	.0034	.0002

Hardness in May, 1888, 1.7. Odor, faintly vegetable, sometimes mouldy.——The samples were collected from a faucet in the pumping station while pumping.

Microscopical Examination.

	1888.		
	March.	April.	May.
1. Blue-green Algæ, ...	0.0	0.0	0.0
2. Other Algæ, ...	pr.	pr.	pr.
3. Fungi, ...	0.0	0.0	0.0
4. Animal Forms, ...	0.0	pr.	0.0

Groups and principal genera of organisms observed: 2. Diatomaceæ. 4. Protozoa; Rotifera.

Water Supply of Natick.

Description of Works. — Population in 1885, 8,460. The works are owned by the town and were built in 1874. The average daily consumption in 1888 was 278,000 gallons. The source of supply is Dug Pond in Natick. The pond has an area of 44½ acres. The watershed contains a comparatively large population. The brook which is the main feeder of the pond flows through the village of Natick, and, as the town has no system of sewerage, the brook is necessarily polluted by the leachings from cesspools. Pumps force the water from the pond to an open distributing reservoir having a capacity of 3,500,000 gallons. The reservoir is situated at the opposite side of the town from the pond. Distributing mains and service pipes are of wrought iron lined with cement.

Chemical Examination of Water from Dug Pond, Natick.

[Parts per 100,000.]

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.	Chlorine.	Nitrates.	Nitrites.
	1887.												
24	May 31	June 2	Very slight.	Slight.	0.20	5.20	2.80	2.40	.0055	.0207	–	–	–
232	June 30	July 1	Slight.	Slight.	0.20	5.52	1.20	4.32	.0030	.0191	.68	.0060	–
453	Aug. 1	Aug. 2	Slight.	None.	0.25	4.97	0.57	4.40	.0000	.0174	.66	.0070	–
669	Aug. 31	Sept. 1	Distinct.	Consid'ble.	0.10	5.17	1.20	3.97	.0008	.0283	.71	.0000	–
873	Oct. 3	Oct. 4	None.	Slight.	0.05	5.37	0.52	4.85	.0032	.0223	.73	.0040	–
1082	Oct. 31	Nov. 1	Very slight.	None.	0.05	5.45 5.20	0.85 0.60	4.60 4.60	.0000	.0182 .0156	.75	.0090	–
1293	Nov. 30	Dec. 1	Sli't, milky.	Slight.	0.10	5.10	1.35	3.75	.0146	.0248	.67	.0040	–
	1888.												
1522	Jan. 2	Jan. 3	Decided.	Sli't, eart'y.	0.40	5.80	1.10	4.70	.0110	.0234	.67	.0100	.0000
1728	Feb. 1	Feb. 2	Very slight.	None.	0.10	5.20	1.10	4.10	.0177	.0199	.68	.0200	.0001
1938	Mar. 1	Mar. 2	Sli't, milky.	Very slight.	0.30	5.40	1.00	4.40	.0132	.0189	.62	.0250	.0006
2146	Apr. 2	Apr. 3	Distinct, milky.	Very slight.	0.10	5.20	1.00	4.20	.0136	.0202	.65	.0250	.0003
2340	May 1	May 2	Distinct.	Slight.	0.10	5.00	0.85	4.15	.0016	.0198	.58	.0200	.0004
2543	June 4	June 4	Slight.	Very slight.	0.15	5.20	1.20	4.00	.0024	.0224 .0206	.64	.0350	.0008
2697	July 2	July 3	Distinct.	Slight.	0.05	5.35	1.40	3.95	.0038	.0230 .0208	.68	.0180	.0003
2873	Aug. 1	Aug. 3	Slight.	Sli't, green.	0.10	5.15	1.20	3.95	.0038	.0404 .0260	.72	.0020	.0001

Chemical Examination of Water from Dug Pond, Natick — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.	1888.											
3052	Sept. 4	Sept. 5	Very slight.	Very slight.	0.00	4.90	0.90	4.00	.0008	.0196 .0176	.62	.0020	.0001
3298	Oct. 1	Oct. 2	Distinct.	Slight.	0.05	4.80	1.05	3.75	.0006	.0262 .0202	.63	.0090	.0004
3482	Oct. 31	Nov. 1	Slight.	Very slight.	0.10	5.15	1.00	4.15	.0128	.0218 .0208	.70	.0200	.0005
3640	Dec. 1	Dec. 4	Sli't, milky.	Very slight.	0.05	5.75	1.25	4.50	.0028	.0180 .0174	.70	.0500	.0004
	1889.	1889.											
3810	Jan. 1	Jan. 2	Sli't, milky.	Very slight.	0.15	5.75	1.05	4.70	.0020	.0156 .0140	.73	.0600	.0006
3964	Feb. 4	Feb. 5	Decided.	Con., white.	0.10	5.25	0.80	4.45	.0010	.0260 .0184	.71	.0450	.0006
4207	Mar. 4	Mar. 5	Distinct.	Con., light green.	0.40	5.30	1.55	3.75	.0044	.0212 .0144	.74	.0500	.0005
4283	Mar. 12	Mar. 13	Slight.	Slight, light green.	0.15	5.35	1.10	4.25	.0040	.0198 .0168	.69	.0500	.0003
4450	Apr. 1	Apr. 2	Sli't, milky.	Very slight.	0.35	5.80	1.40	4.40	.0024	.0160 .0160	.70	.0600	.0003
4606	May 1	May 2	Slight.	Very slight.	0.20	5.60	1.40	4.20	.0010	.0222 .0174	.69	.0400	.0006
Av.	....	....	....	....	0.15	5.29	0.98	4.31	.0050	.0218	.68	.0238	.0004

Hardness in May, 1888, 2.3; March 12, 1889, 2.6. Odor, vegetable and mouldy, often disagreeable. —— The samples were collected from a faucet at the pumping station while pumping, or from the pond near the pumping station.

Microscopical Examination.

	1888. July.	1888. Aug.	1888. Sept.	1888. Oct.	1888. Nov.	1888. Dec.	1889. Jan.	1889. Feb.	1889. Mar.	1889. Mar.	1889. Apr.	1889. May.
1. Blue-green Algæ, . .	pr.	0.2	pr.	pr.	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, . . .	0.6	1.8	0.9	1.0	2.7	4.1	15.7	333.2	1501.6	500.9	52.5	1.2
3. Fungi, ...	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, . .	1.4	2.3	pr.	0.6	1.1	pr.	0.0	0.7	0.0	0.5	pr.	0.3

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Asterionella*, *Stephanodiscus*, *Synedra*. 3. Schizomycetes. 4. Protozoa, *Dinobryon*, *Peridinium*, *Trachelomonas;* Nematoda; Rotifera; Entomostraca. The genus *Asterionella* was by far the most abundant of the algæ present in January, February, March and April, 1889.

Table showing Heights of Water in Dug Pond at Times when Samples of Water were collected for Analysis.

NOTE : — High-water mark is 13.00 feet.

DATE.	Height of Water.	DATE.	Height of Water.
1888.		**1888.**	
January 2, ...	8.25	October 1, ...	12.00
February 1, ...	8.71	October 31, ...	13.25
March 1, ...	11.58	December 1, ...	14.46
April 2, ...	13.87	**1889.**	
May 1, ...	13.12	January 1, ...	13.60
June 4, ...	13.00	February 4, ...	13.60
July 2, ...	11.67	March 4, ...	13.10
August 1, ...	10.43	April 1, ...	13.20
September 4, ...	9.75	May 1, ...	13.25

Chemical Examination of Water from the Distributing Reservoir of the Natick Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
4284	Mar. 12	Mar. 13	Slight.	Slight, light green.	0.10	5.05	1.35	3.70	.0020	.0202 .0170	.68	.0450	.0006

Hardness, 2.5. Odor, none. —— The sample was collected from the distributing reservoir.

Microscopical Examination.

March, 1889. 1. Blue-green algæ, 0.0; 2. Other algæ, 606.0; 3. Fungi, 0.0; 4. Animal forms, 0.5. Groups and principal genera of organisms observed: 2. Diatomaceæ, *Asterionella*. 4. Protozoa.

Chemical Examination of Water from Faucets in Natick supplied from the Natick Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
4285	Mar. 12	Mar. 13	Very slight.	Slight, light green.	0.10	5.65	1.55	4.10	.0000	.0168 .0144	.68	.0620	.0002
4286	Mar. 12	Mar. 13	Very slight.	Slight, light green.	0.15	6.50	1.80	4.70	.0006	.0158 .0148	.69	.0600	.0002

Hardness of No. 4285, 2.4; of No. 4286, 2.8. Odor of 4285, none; of 4286, none. —— Sample No. 4285 was collected from a faucet on Florence Street; No. 4286 from a faucet on Washington Avenue.

Microscopical Examination.

No. 4285. 1. Blue-green algæ, 0.0; 2. Other algæ, 302.1; 3. Fungi, 0.0; 4. Animal forms, 0.0.
No. 4286. 1. Blue-green algæ, 0.0; 2. Other algæ, 4.2; 3. Fungi, 0.0; 4. Animal forms, 0.0.
Groups and principal genera of organisms observed: 2. Palmellaceæ; Diatomaceæ, *Asterionella*, *Stephanodiscus*.

NEEDHAM.

Chemical Examination of Water from Rosemary Pond.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1888.												
3708	Dec. 13	Dec. 14	Distinct.	Slight.	0.2				.0028	.0134	.64	.0500	.0005
						4.60	1.60	3.00		.0122			
	1889.												
4148	Feb. 27	Feb. 28	Distinct.	Very slight.	0.3				.0000	.0226	.54	.0200	.0004
						5.80	2.30	3.50		.0184			

Odor, faintly mouldy. —— The samples were collected from the pond near the ice-house of the Rosemary Ice Company.

Chemical Examination of Water from Springs in Needham.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1887.												
1300	Dec. 1	Dec. 2	None.	None.	0.0	4.30	–	–	.0000	.0012	.44	.1000	.0000
1301	Dec. 1	Dec. 2	None.	Very slight.	0.0	6.00	–	–	.0000	.0032	.79	.1200	.0000

Odor, none. —— Sample No. 1300 was collected from Hicks' Spring. Sample No. 1301 was collected from Colburn's Spring. These samples were collected while investigations with reference to a public water supply for Needham were being made.

WATER SUPPLY OF NEW BEDFORD.

Description of Works. — Population in 1885, 33,393. The works are owned by the city. Water was introduced in December, 1869. The average daily consumption in 1887 was 3,360,000 gallons. The source of supply is a storage reservoir on the Acushnet River

in Acushnet, supplemented by Little Quittacas Pond in Lakeville. The area of the storage reservoir is 300 acres and its available capacity, above the conduit, is 400,000,000 gallons. The bottom is muddy. The reservoir is quite shallow, the water being not more than two feet in depth, at high water, over about one-fourth of it. The watershed of the reservoir is quite generally covered with woods, mostly of pine, oak and cedar. It contains very few inhabitants and no factories or mills. Its area is about 3,300 acres.

Little Quittacas Pond was connected with the storage reservoir in 1886 by reopening a former natural outlet which had been filled up. The area of Little Quittacas Pond is 335 acres and the area of its watershed is said to be 1,125 acres. The watershed is uninhabited.

An egg-shaped brick conduit four feet high and three feet wide carries the water by gravity from the storage reservoir to the receiving reservoir in New Bedford, a distance of $5\frac{5}{8}$ miles. The receiving reservoir has a capacity of three million gallons and a depth of 12 feet when full. The bottom of this reservoir was cleared of all loam and vegetable growth and the slopes are paved over a puddling of clay. From the receiving reservoir water is pumped to the distributing reservoir. The area of this reservoir when full is $3\frac{1}{8}$ acres and its depth is 17 feet. It contains 14,000,000 gallons of water. The slopes of this reservoir are paved over a puddling of clay and the bottom is of clay.

An iron standpipe 5 feet in diameter, and rising to an elevation of 43 feet above high water in the distributing reservoir, was built in 1873 in connection with works for supplying the high-service district.

There were about 52 miles of distributing mains in 1887. Of this length 9 miles were of wrought iron lined with cement and the remainder were of cast iron. Extensions are made with cast iron. Service pipes are of lead.

For many years after the works were built, a disagreeable taste and odor in the water was complained of during the summer months when the temperature of the water was highest. This trouble occurred annually until 1886, but has not been noticed since that year. The storage reservoir has been kept practically full during the past three years by drawing water when necessary from Little Quittacas Pond.

Chemical Examination of Water from the Conduit of the New Bedford Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
167	June 22	June 23	Slight.	Slight.	1.80	5.40	2.55	2.85	.0030	.0366	.47	.0130	–
386	July 22	July 22	Very slight.	None.	2.20	5.40	2.00	3.40	.0025	.0360	.52	.0160	–
603	Aug. 23	Aug. 23	Very slight.	None.	1.40	5.05	1.92	3.13	.0022	.0320	.49	.0100	–
806	Sept. 17	Sept. 17	Slight.	Sli't, rusty.	1.20	5.05	1.85	3.20	.0006	.0260	.57	.0070	–
1014	Oct. 24	Oct. 24	Very slight.	Sl't, earthy.	0.90	4.75	1.25	3.50	.0005	.0256	.59	.0200	–
1244	Nov. 22	Nov. 22	Slight.	Very slight.	1.20	4.85	1.95	2.90	.0024	.0242	.60	.0100	–
1472	Dec. 22	Dec. 22	Slight.	Slight.	0.90	5.60	2.10	3.50	.0033	.0268	.66	.0200	–
	1888.												
1661	Jan. 23	Jan. 24	Distinct.	Very slight.	1.50	6.70	3.00	3.70	.0022	.0237	.61	.0400	.0001
1869	Feb. 20	Feb. 20	Slight.	None.	1.30	6.25	2.75	3.50	.0031	.0266	.67	.0200	.0001
2087	Mar. 22	Mar. 22	Slight.	Very slight.	1.00	4.25	1.55	2.70	.0012	.0173	.52	.0070	.0001
2284	Apr. 23	Apr. 23	Very slight.	Sli't, brown.	1.40	4.45	1.75	2.70	.0013	.0228	.48	.0150	.0001
2483	May 22	May 22	Very slight.	Sl't, rusty brown.	1.50	4.55	2.25	2.30	.0006	.0216	.46	.0150	.0001
2684	June 28	June 29	Slight.	Sli't, brown.	2.30	5.30	2.85	2.45	.0022	.0332 .0296	.50	.0050	.0002
2854	July 26	July 27	Very slight.	Very slight.	1.80	4.90	1.90	3.00	.0004	.0306 .0278	.49	.0170	.0003
3040	Aug. 30	Aug. 31	None.	Very slight.	1.00	4.55	2.00	2.55	.0006	.0226 .0212	.44	.0050	.0000
3278	Sept. 27	Sept. 28	Very slight.	Very slight.	0.70	4.00	1.55	2.45	.0000	.0260 .0236	.48	.0180	.0001
3452	Oct. 26	Oct. 27	Very slight.	Very slight.	2.00	6.10	3.15	2.95	.0018	.0310 .0286	.50	.0200	.0002
3619	Nov. 28	Nov. 30	Very slight	Slight.	1.80	6.45	2.75	3.70	.0028	.0238 .0222	.62	.0450	.0002
3771	Dec. 20	Dec. 21	None.	Very slight.	1.50	4.80	2.30	2.50	.0000	.0252 .0240	.54	.0120	.0001
	1889.												
3921	Jan. 24	Jan. 25	Very slight.	Very slight.	1.30	4.15	2.10	2.05	.0010	.0182 .0174	.48	.0120	.0001
4165	Feb. 28	Feb. 28	Very slight.	Very slight, earthy.	1.00	4.00	1.70	2.30	.0002	.0124 .0120	.49	.0120	.0004
4423	Mar. 29	Mar. 29	Slight.	Slight.	0.70	3.55	1.50	2.05	.0006	.0142 .0128	.47	.0050	.0001
4591	Apr. 29	Apr. 30	Very slight.	Slight.	1.00	4.00	1.50	2.50	.0022	.0184 .0158	.51	.0080	.0001
4731	May 23	May 24	Very slight.	Slight.	1.30	4.10	1.90	2.20	.0004	.0198 .0188	.54	.0080	.0002
Av.	....	....	....	....	1.36	5.19	2.08	3.11	.0015	.0248	.53	.0150	.0001

Hardness in May, 1888, 1.1. Odor, faintly vegetable, sometimes none.——The samples were collected from the conduit where it enters the receiving reservoir.

Microscopical Examination.

	1888.							1889.				
	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ, . . .	0.0	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	1.8	1.5	pr.	pr.	0.0	0.2	0.1	pr.	pr.	0.1	0.0	0.0
3. Fungi, ...	0.6	0.5	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, ...	pr.	0.0	0.0	0.0	0.0	0.0	pr.	0.0	0.0	0.3	0.0	pr.

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ, *Chlorococcus;* Zoosporeæ; Desmidiaceæ; Diatomaceæ. 3. Schizomycetes. 4. Protozoa; Spongiaria; Rotifera; Entomostraca.

Chemical Examination of Water from the Storage Reservoir of the New Bedford Water Works in Acushnet.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
166	June 21	June 23	Slight.	Slight.	2.0	5.35	–	–	.0043	.0372	.44	.0190	–

Odor, none.——The sample was collected from the gate-house at the storage reservoir. The water was drawn from within one foot of the surface.

Chemical Examination of Water from the Distributing Reservoir of the New Bedford Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
168	June 22	June 23	Distinct.	Slight.	1.80	5.22	2.82	2.40	.0052	.0308	.51	.0130	–
387	July 22	July 22	Very slight.	None.	2.20	5.30	2.17	3.13	.0018	.0358	.52	.0190	–
604	Aug. 23	Aug. 23	Very slight.	None.	1.40	5.07	1.97	3.10	.0025	.0302	.47	.0130	–
807	Sept. 17	Sept. 17	Very slight.	Very slight.	1.10	5.00	1.90	3.10	.0006	.0281	.55	.0070	–
1015	Oct. 24	Oct. 24	Very slight.	Sli't, earthy and floc't.	1.20	4.60	1.55	3.05	.0008	.0292	.55	.0100	–
1245	Nov. 22	Nov. 22	Slight.	Slight.	1.10	4.85	2.00	2.85	.0022	.0242	.63	.0150	–
1473	Dec. 22	Dec. 22	Slight	Slight.	1.20	5.60	2.70	2.90	.0035	.0257	.66	.0180	–
	1888.												
1662	Jan. 23	Jan. 24	Slight.	Very slight.	1.80	6.35	3.10	3.25	.0022	.0286	.52	.0250	.0000
1870	Feb. 20	Feb. 20	Slight.	Very slight.	1.30	6.75	2.70	4.05	.0022	.0295	.62	.0080	.0000
2086	Mar. 22	Mar. 22	Slight.	None.	1.00	4.20	1.90	2.30	.0004	.0195	.51	.0060	.0000
Av.	....	....	....	....	1.41	5.29	2.28	3.01	.0021	.0282	.55	.0134	.0000

Odor, faintly vegetable.——The samples were collected at the outlet gate-house five feet beneath the surface.

Microscopical Examination.

March, 1888. 1. Blue-green algæ, 0.0; 2. Other algæ, pr.; 3. Fungi, 0.0; 4. Animal forms, pr. Groups and principal genera of organisms observed: 2. Desmidiaceæ. 4. Protozoa; Spongiaria.

Chemical Examination of Water from a Faucet at City Hall, New Bedford.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.	1888.											
2285	Apr. 23	Apr. 23	Slight.	None.	1.4	4.20	1.55	2.65	.0014	.0221	.49	.0150	.0001
2484	May 22	May 22	Very slight.	Slight.	1.2	4.55	2.00	2.55	.0000	.0216	.47	.0120	.0001

Hardness in May, 1.1. Odor, very faintly vegetable. —— The samples were collected from a faucet at City Hall. The distributing reservoir was empty at the time these samples were collected, and the city was being supplied by pumping directly into the mains.

Microscopical Examination.

April, May, 1888. 1. Blue-green algæ, 0.0; 2. Other algæ, pr.; 3. Fungi, 0.0; 4. Animal forms, pr. in April only.

Groups and principal genera of organisms observed: 2. Zoosporeæ; Diatomaceæ. 4. Protozoa.

Water Supply of Newburyport. — Newburyport Water Company.

Description of Works. — Population in 1885, 13,716. The works are owned by the Newburyport Water Company and were built in 1881. The average daily consumption in 1888 was about 314,000 gallons. The sources of supply are some large springs near the southern bank of the Merrimack River above the city. The springs contributed most of the water to a small brook which ran into the Merrimack River. A low dam was built across the estuary of this brook near where it entered the river, and one suction pipe from the pumping station leads to the small reservoir formed by the dam. Subsequently two wells were sunk not far from the reservoir, and the whole supply is now drawn from these wells. One of the wells is 20 feet in diameter and 18 feet deep. The other is smaller. Neither of the wells is covered. The water is pumped to an open iron tank near the city, 40 feet in diameter and 35 feet high. Distributing mains are of wrought iron lined with cement and of cast iron. Service pipes are of wrought iron lined with cement.

Chemical Examination of Water from the Well of the Newburyport Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
76	June 10	June 11	None.	None.	0.00	4.97	–	–	.0003	.0021	.45	.0520	–
389	July 21	July 22	None.	None.	0.00	4.97	–	–	.0001	.0004	.44	.0460	–
676	Sept. 1	Sept. 3	None.	Sli't, brown.	0.00	5.87	–	–	.0011	.0029	.41	.0100	–
1099	Nov. 2	Nov. 4	Very slight.	Very slight.	0.00	5.90	–	–	.0000	.0018	.43	.0200	–
1116	Nov. 7	Nov. 8	Distinct.	Consid'ble.	0.05	6.00	–	–	.0000	.0036	.47	.0300	–
	1888.												
1566	Jan. 9	Jan. 10	Slight.	Very slight.	0.00	5.10	–	–	.0000	.0000	.43	.0500	.0001
1813	Feb. 13	Feb. 14	Very slight.	Very slight.	0.05	5.15	–	–	.0000	.0024	.49	.0280	.0001
1996	Mar. 12	Mar. 13	Sli't, milky.	Very slight, white.	0.10	5.00	–	–	.0000	.0038	.46	.0330	.0000
2241	Apr. 16	Apr. 18	Slight.	None.	0.10	4.65	–	–	.0000	.0052	.42	.0250	.0002
2403	May 10	May 12	Slight.	Very slight.	0.00	6.30	–	–	.0020	.0094	.46	.0180	.0002
Av.	....	....	....	....	0.03	5.39	–	–	.0004	.0032	.45	.0312	.0001

Hardness in May, 1888, 2.7. Odor, generally none.——The samples were collected from the well with the exception of 1116, 1813, 1996, 2241 and 2403, which were collected from a faucet in the city near the centre of distribution.

Microscopical Examination.

April, 1888. 1. Blue-green algæ, 0.0.; 2. Other algæ, pr.; 3. Fungi, pr.; 4. Animal forms, 0.0.
May, 1888. 1. Blue-green algæ, 0.0; 2. Other algæ, pr.; 3. Fungi, 0.0; 4. Animal forms, 0.0.
Groups and principal genera of organisms observed: 2. Diatomaceæ. 3. Schizomycetes.

Chemical Examination of Water from the Small Storage Reservoir of the Newburyport Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
388	July 21	July 22	None.	None.	0.0	9.20	–	–	.0004	.0011	.98	.2200	–

Odor, none.——The sample was collected from the reservoir near the pumping station. The site of this reservoir was formerly covered with salt water at every high tide.

Water Supply of Newton.

Description of Works.—Population in 1885, 19,759. The works are owned by the city and were built in 1876. The average daily consumption in 1888 was 708,000 gallons. The source of supply is a filter-basin on the left bank of Charles River in Needham, near Newton Upper Falls, supplemented by tubular wells on the opposite side of the river. There is also a direct connection with the river for use in an emergency.

The filter-basin is 1,575 feet in length and parallel with the river. Its greatest width at the top varies from 70 to 88 feet, and its bottom is about 10 feet below the ordinary level of the water in the river. Between the filter-basin and the river there is an embankment of sufficient height to keep out river water during freshets. Several tubular wells are sunk in the bottom of the basin to a depth of from 25 to 35 feet below ordinary water level in the basin.

The tubular wells on the opposite side of the river are eight in number, and water flows by gravity from them into the pump well at the pumping station. Four of these wells are each six inches in diameter and the others are four inches in diameter.

Much of the water is pumped directly to the consumers, only the surplus going to a distributing reservoir located at the opposite end of the city. This reservoir is approximately a pentagon in outline; its depth at high water is 18 feet and its capacity is 15,000,000 gallons. The bottom is of concrete 6 inches in thickness, and the slopes are paved. Water enters the reservoir at one corner and is drawn out at the opposite side. Distributing mains are of cast iron. For service pipes tar-coated wrought iron was used originally, and afterward enameled iron. Lead has generally been used since 1885.

Complaints of a disagreeable taste and odor in the water have been made, the most serious trouble occurring in 1883. As a remedy at that time the basin was drawn off in sections and cleaned. Since 1883 no vegetable growth has been allowed to collect on the bottom or sides of the filter-basin, and there have been but few complaints of the taste or odor of the water.

Chemical Examination of Water from the Filter-Basin of the Newton Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
39	June 6	June 7	Slight.	None.	0.00	4.75	–	–	.0002	.0100	.42	–	–
271	July 6	July 7	Very slight.	Slight.	0.00	4.80	–	–	.0012	.0046	.37	.0030	–
504	Aug. 8	Aug. 9	None.	Very slight.	0.00	4.92	–	–	.0007	.0094	.34	.0000	–
727	Sept. 9	Sept. 10	Slight.	Slight.	0.00	4.87	–	–	.0000	.0096	.36	.0070	–
930	Oct. 10	Oct. 12	Very slight.	None.	0.00	5.05	–	–	.0010	.0054	.36	.0050	–
1124	Nov. 8	Nov. 9	Very slight.	Very slight.	0.00	5.05	–	–	.0000	.0070	.39	.0050	–
1366	Dec. 8	Dec. 9	None.	Very slight.	0.00	5.35	–	–	.0006	.0030	.40	.0080	–
	1888.												
1568	Jan. 9	Jan. 11	Slight.	Very slight.	0.00	4.70	–	–	.0000	.0046	.42	.0200	.0001
1779	Feb. 7	Feb. 9	Very slight.	Very slight, white.	0.00	4.65	–	–	.0006	.0046	.39	.0090	.0001
1972	Mar. 7	Mar. 8	Slight.	Very slight.	0.00	4.65	–	–	.0000	.0058	.37	.0100	.0002
2187	Apr. 10	Apr. 11	Distinct.	Very slight.	0.00	4.30	–	–	.0000	.0110	.34	.0050	.0001
2378	May 8	May 9	Distinct.	Very slight.	0.10	4.70	–	–	.0028	.0140	.34	.0030	.0000
2563	June 7	June 8	None.	Sli't, earthy and floc't.	0.00	**3.80**	–	–	.0000	.0076 **.0044**	.28	.0040	.0000
2717	July 5	July 6	Very slight.	None.	0.05	**4.20**	–	–	.0022	.0082 **.0072**	.30	.0030	.0000
2899	Aug. 9	Aug. 10	Very slight.	None.	0.00	4.55 **4.45**	–	–	.0000	.0078 **.0052**	.35	.0030	.0001
3162	Sept. 12	Sept. 13	Very slight.	Sli't, earthy and floc't.	0.00	**5.30**	–	–	.0028	.0112 **.0084**	.36	.0120	.0001
3357	Oct. 11	Oct. 12	Distinct.	Sli't, green.	0.00	**4.60**	–	–	.0022	.0176 **.0092**	.36	.0070	.0000
3513	Nov. 8	Nov. 9	Distinct.	Slight.	0.00	5.05 **4.70**	–	–	.0000	.0172 **.0082**	.33	.0050	.0000
3669	Dec. 6	Dec. 7	Distinct.	Sli't, green.	0.00	5.20 **4.25**	–	–	.0000	.0238 **.0098**	.35	.0050	.0000
	1889.												
3933	Jan. 24	Jan. 26	Very slight.	Slight.	0.00	4.00	–	–	.0012	.0108 **.0024**	.28	.0050	.0001
3988	Feb. 7	Feb. 8	Distinct.	Con., yellow white.	0.00	**3.55**	–	–	.0000	.0036 **.0024**	.28	.0100	.0000
4081	Feb. 21	Feb. 23	Very slight.	Slight.	0.00	3.70	–	–	.0000	.0044	.30	.0300	.0004
4242	Mar. 7	Mar. 8	Very slight.	Sli't, gray.	0.00	4.40	–	–	.0000	.0046	.30	.0120	.0001
4496	Apr. 11	Apr. 12	Very slight.	Very slight.	0.03	3.85	–	–	.0000	.0042 **.0016**	.32	.0100	.0001
4639	May 9	May 11	None.	Sli't, earthy.	0.00	4.10	–	–	.0000	.0046 **.0028**	.32	.0150	.0000
Av.	....	....	....	....	–	4.63	–	–	.0006	.0086	.35	.0082	.0001

Hardness in May, 1888, 2.1. Odor, sometimes none, frequently disagreeable. —— The samples were collected from the filter-basin.

Microscopical Examination.

	1888.							1889.					
	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ, . .	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, . . .	1.6	0.4	1.5	1.4	4.7	15.5	38.5	340.5	205.0	68.6	37.2	6.6	1.5
3. Fungi, ...	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, . .	0.4	1.5	0.1	pr.	50.0	0.0	0.0	0.0	25.0	30.0	0.0	0.0	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ, *Chlorococcus*, *Protococcus*; Zoosporeæ, *Scenedesmus*; Desmidiaceæ; Diatomaceæ, *Asterionella*, *Melosira*, *Stauroneis*, *Synedra*; Zygnemaceæ. 3. Schizomycetes. 4. Protozoa, *Trachelomonas*; Spongiaria.

Chemical Examination of Water from the Distributing Reservoir of the Newton Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
51	June 7	June 8	None.	Very slight.	0.00	4.72	–	–	.0014	.0103	.28	.0030	–
270	July 6	July 7	Slight.	Slight.	0.00	4.70	–	–	.0012	.0120	.35	.0000	–
507	Aug. 8	Aug. 9	None.	Very slight.	0.00	4.85	–	–	.0009	.0082	.35	.0000	–
728	Sept. 9	Sept. 10	Distinct.	Slight.	0.00	5.05	–	–	.0000	.0105	.34	.0070	–
931	Oct. 10	Oct. 12	Slight.	Very slight.	0.00	4.75	–	–	.0012	.0106	.35	.0030	–
1125	Nov. 8	Nov. 9	Very slight.	Very slight.	0.00	5.00	–	–	.0000	.0072	.36	.0000	–
1365	Dec. 8	Dec. 9	Very slight.	Sli't, white.	0.00	4.95	–	–	.0000	.0090	.39	.0040	–
	1888.												
1569	Jan. 9	Jan. 11	–	–	0.00	5.05	–	–	.0014	.0084	.41	.0030	.0001
1780	Feb. 7	Feb. 9	Very slight.	Sli't, earthy and floc't.	0.00	4.85	–	–	.0000	.0053	.35	.0080	.0001
1971	Mar. 7	Mar. 8	Slight.	Very slight, earthy.	0.00	4.30	–	–	.0000	.0106	.38	.0050	.0002
2188	Apr. 10	Apr. 11	Distinct.	Very slight.	0.00	4.15	–	–	.0004	.0134	.38	.0020	.0000
2379	May 8	May 9	Distinct.	Very slight.	0.00	4.50	–	–	.0000	.0102	.34	.0050	.0000
2564	June 7	June 8	Very slight.	Sli't, earthy and floc't.	0.00	4.15	–	–	.0000	.0158 .0072	.31	.0010	.0001
2736	July 6	July 7	Very slight.	Very slight.	0.00	4.70	–	–	.0004	.0112 .0076	.33	.0020	.0000
2900	Aug. 9	Aug. 10	Very slight.	Sli't, earthy and rusty.	0.00	4.60 4.45	–	–	.0000	.0118 .0062	.34	.0000	.0000

Chemical Examination of Water from the Distributing Reservoir of the Newton Water Works — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
3163	Sept. 12	Sept. 13	Slight.	Sli't, green.	0.00	 4.60	–	–	.0008	.0142 .0072	.32	.0080	.0000
3356	Oct. 11	Oct. 12	Slight.	Sli't, white.	0.00	 4.60	–	–	.0004	.0148 .0128	.35	.0050	.0000
3514	Nov. 8	Nov. 9	Slight.	Slight.	0.00	4.60 4.30	–	–	.0000	.0148 .0090	.34	.0040	.0001
3670	Dec. 6	Dec. 7	Distinct.	Very slight, green.	0.00	4.60 4.55	–	–	.0000	.0156 .0080	.34	.0030	.0000
	1889.												
3934	Jan. 24	Jan. 26	Very slight.	Sli't, green.	0.00	4.65 4.15	–	–	.0000	.0148 .0040	.31	.0000	.0001
3989	Feb. 7	Feb. 8	Distinct.	Sli't, white.	0.00	 3.95	–	–	.0006	.0094 .0036	.31	.0030	.0000
4082	Feb. 21	Feb. 23	Slight.	Con., green.	0.00	4.25 4.20	–	–	.0006	.0084 .0044	.33	.0050	.0003
4243	Mar. 7	Mar. 8	Slight.	Con., light green.	0.00	4.15 4.05	–	–	.0000	.0116 .0030	.29	.0040	.0001
4497	Apr. 11	Apr. 12	Slight.	Slight.	0.00	4.15 3.85	–	–	.0000	.0142 .0058	.31	.0020	.0000
4640	May 9	May 11	Slight.	Con., light green.	0.00	4.25	–	–	.0008	.0124 .0050	.33	.0020	.0000
Av.	....	....	....	....	0.00	4.61	–	–	.0004	.0114	.34	.0032	.0001

Hardness in May, 1888, 2.1. Odor, sometimes none, frequently disagreeable. — The samples were collected from the distributing reservoir.

Microscopical Examination.

	1888. June.	1888. July.	1888. Aug.	1888. Sept.	1888. Oct.	1888. Nov.	1888. Dec.	1889. Jan.	1889. Feb.	1889. Feb.	1889. Mar.	1889. Apr.	1889. May.
1. Blue-green Algæ, . .	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	0.0	0.0	0.0
2. Other Algæ, . . .	1.6	0.5	1.7	0.1	7.3	60.2	145.0	102.0	90.6	60.0	56.2	325.0	225.0
3. Fungi, ...	pr.	0.0	pr.	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, . .	0.0	0.0	pr.	0.0	pr.	0.0	0.0	0.0	5.2	5.0	0.2	0.0	pr.

Groups and principal genera of organisms observed: 1. Cyanophyceæ, *Aphanocapsa*. 2. Palmellaceæ, *Chlorococcus, Protococcus;* Zoosporeæ, *Raphidium, Scenedesmus;* Desmidiaceæ; Diatomaceæ, *Asterionella, Synedra*. 3. Schizomycetes. 4. Protozoa, *Trachelomonas;* Rotifera; Entomostraca.

Chemical Examination of Water from the Tubular Wells of the Newton Water Works.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1887.												
52	June 7	June 8	Very slight.	None.	0.0	7.37	–	–	.0008	.0014	.37	.0130	–
273	July 6	July 7	None.	None.	0.0	7.45	–	–	.0000	.0002	.41	.0130	–
506	Aug. 8	Aug. 9	None.	None.	0.0	7.12	–	–	.0000	.0007	.29	.0220	–
729	Sept. 9	Sept. 10	None.	None.	0.0	7.30	–	–	.0000	.0002	.38	.0130	–
Av.	....	....	....	....	0.0	7.31	–	–	.0002	.0006	.36	.0153	–

Odor, none.——The samples were collected from a faucet at the pumping station, while pumping from the tubular wells.

Chemical Examination of Water from Charles River opposite the Filter-Basin of the Newton Water Works.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1887.												
40	June 6	June 7	Very slight.	Slight.	1.00	5.95	1.92	4.03	.0020	.0396	.39	.0000	–
272	July 6	July 7	Slight.	Sli't, brown.	0.70	5.07	1.62	3.45	.0004	.0202	.38	.0000	–
505	Aug. 8	Aug. 9	None.	Slight.	1.00	5.60	1.80	3.80	.0008	.0249	.38	.0000	–
726	Sept. 9	Sept. 10	Slight.	Very slight.	0.70	5.62	1.40	4.22	.0011	.0307	.43	.0070	–
929	Oct. 10	Oct. 12	Very slight.	None.	0.40	5.30	1.25	4.05	.0000	.0208	.50	.0050	–
1123	Nov. 8	Nov. 9	Slight.	Slight.	0.60	5.65	0.95	4.70	.0004	.0242	.62	.0080	–
1364	Dec. 8	Dec. 9	Slight.	Very slight.	0.70	6.20	1.80	4.40	.0004	.0240	.56	.0180	–
	1888.												
1567	Jan. 9	Jan. 11	Slight.	Very slight.	0.70	5.10	2.00	3.10	.0000	.0235	.31	.0250	.0000
1778	Feb. 7	Feb. 9	Very slight.	Very slight, white.	0.50	4.95	1.70	3.25	.0051	.0260	.37	.0230	.0001
1970	Mar. 7	Mar. 8	Distinct.	Slight.	0.70	4.75	1.80	2.95	.0003	.0277	.31	.0100	.0000
2186	Apr. 10	Apr. 11	Distinct.	Slight.	0.65	3.85	1.50	2.35	.0004	.0297	.29	.0050	.0001
2377	May 8	May 9	Distinct.	Con., brown.	0.90	4.55	1.75	2.80	.0028	.0322	.36	.0100	.0001
2562	June 7	June 8	Very slight.	Consid'ble.	1.20	4.65	1.85	2.80	.0012	.0348 .0292	.29	.0060	.0007

Chemical Examination of Water from Charles River opposite the Filter-Basin of the Newton Water Works — Concluded.

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1888.												
2718	July 5	July 6	Very slight.	Very slight.	0.60	4.35	1.65	2.70	.0032	.0240 .0240	.34	.0070	.0000
2898	Aug. 9	Aug. 10	Slight.	Very slight.	0.20	4.35	1.15	3.20	.0000	.0212 .0212	.44	.0020	.0000
3161	Sept. 12	Sept. 13	Very slight.	Very slight.	1.00	6.30	2.65	3.65	.0016	.0340 .0328	.38	.0150	.0001
3355	Oct. 11	Oct. 12	Very slight.	Very slight.	1.90	5.55	2.40	3.15	.0004	.0300 .0262	.37	.0070	.0002
3512	Nov. 8	Nov. 9	Very slight.	Very slight.	1.30	4.90	2.30	2.60	.0010	.0304 .0278	.39	.0080	.0001
3668	Dec. 6	Dec. 7	Very slight.	Very slight.	0.60	3.85	1.55	2.30	.0006	.0180 .0148	.34	.0130	.0001
	1889.												
3932	Jan. 25	Jan. 26	Very slight.	Very slight.	0.50	3.45	1.15	2.30	.0002	.0160 .0144	.31	.0060	.0002
3987	Feb. 7	Feb. 8	Very slight.	Sli't, white.	0.50	3.75	1.20	2.55	.0002	.0140 .0122	.34	.0090	.0002
4080	Feb. 21	Feb. 23	Slight.	Slight.	0.30	3.70	1.05	2.65	.0000	.0178 .0174	.32	.0200	.0004
4241	Mar. 7	Mar. 8	Distinct.	Slight.	0.30	3.60	1.20	2.40	.0000	.0182 .0140	.31	.0090	.0002
4495	Apr. 11	Apr. 12	Slight.	Very slight.	0.70	3.75	1.30	2.45	.0004	.0222 .0212	.33	.0030	.0003
4638	May 9	May 11	Slight.	Consid'ble.	1.20	4.45	2.25	2.20	.0036	.0352 .0318	.32	.0040	.0002
Av.	....	....	....	....	0.75	5.22	1.62	3.60	.0010	.0256	.38	.0088	.0002

Hardness in May, 1888, 1.7. Odor, distinctly vegetable. —— The samples were collected from the river.

Microscopical Examination.

	1888.							1889.					
	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ, . .	0.0	0.0	pr.	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	4.4	0.9	0.3	1.2	0.6	0.5	0.9	0.1	4.9	1.8	20.6	2.2	6.7
3. Fungi, ...	0.4	0.0	0.0	pr.	0.5	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, . . .	0.1	pr.	0.1	0.1	0.2	0.5	pr.	0.0	1.2	0.0	0.2	0.2	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Synedra*, *Tabellaria;* Zygnemaceæ. 3. Schizomycetes. 4. Protozoa, *Dinobryon;* Spongiaria; Annelida; Entomostraca.

Chemical Examination of Water from Hammond's Pond, Newton.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
4376	Mar. 22	Mar. 22	Distinct.	Slight.	1.1	5.40	2.00	3.40	.0038	.0450 .0340	.54	.0040	.0003

Odor, none.—The sample was collected from the southerly end of the pond from the end of an ice run.

Water Supply of North Adams Fire District, North Adams.

Description of Works. — Population of the town in 1885, 12,540. Estimated population of the fire district, 10,000. The works are owned by the fire district, and were built in 1861. The consumption of water in summer is said to be as high as 1,100,000 gallons per day. The present sources of supply are Notch Brook, about two miles south-westerly from the town, and some tubular wells in the town. The water of the brook is diverted by a low dam into pipes leading to the town. Above this dam the brook has a very steep and rocky drainage area of 2.46 square miles. On the line of the pipes leading to the town two reservoirs have been built. The first reservoir, situated at an elevation of about 400 feet above the town, is the larger one, and is used as a storage reservoir. Its shape is approximately rectangular; its area is 1.75 acres, and its depth when full is 14 feet. Its capacity is about 6,000,000 gallons. The bottom and the lower half of the slopes are concreted; the upper half is paved. The second reservoir is nearer the town, at a lower level, and is used as a distributing reservoir. It is about 150 feet square, and contains 9 feet of water when full. The wells, added in 1884 though not used until 1886, are said to consist of two 8-inch pipes sunk 500 feet, mostly through rock, until a seam of sandstone or sand was reached. They are used only when the Notch Brook supply is insufficient, as the water from them is very hard. These wells are located in a swampy district with a large population in and about it. Distributing mains are of cast iron; service pipes are of wrought iron, a part of them being galvanized.

Works for obtaining an additional supply from Broad Brook in Pownal, Vt., are now nearly finished.

Chemical Examination of Water from a Faucet in North Adams, supplied from Notch Brook.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
53	June 7	June 8	Very slight.	Very slight.	0.00	8.60	1.42	7.18	.0003	.0049	.07	.0030	–
276	July 7	July 8	Distinct.	Sli't, brown.	0.00	8.45	1.20	7.25	.0004	.0046	.06	.0000	–
472	Aug. 3	Aug. 4	Distinct.	Slight.	0.10	8.50	0.20	8.30	.0002	.0057	.06	.0070	–
898	Oct. 6	Oct. 7	None.	None.	0.00	9.62	0.15	9.47	.0002	.0026	.04	.0000	–
1103	Nov. 3	Nov. 4	Slight.	Con., earthy and floc't.	0.00	10.30	0.70	9.60	.0000	.0022	.07	.0050	–
1329	Dec. 5	Dec. 7	Very slight.	Very slight.	0.00	6.75	0.55	6.20	.0000	.0040	.08	.0100	–
	1888.												
1531	Jan. 4	Jan. 5	Very slight.	Very slight.	0.00	6.55	0.70	5.85	.0000	.0050	.09	.0100	.0000
1746	Feb. 3	Feb. 4	Very slight.	None.	0.00	7.45	0.75	6.70	.0000	.0016	.08	.0100	.0000
1952	Mar. 3	Mar. 6	Slight.	Sli't, earthy and floc't.	0.05	7.00	0.20	6.80	.0000	.0018	.07	.0090	.0000
2161	Apr. 4	Apr. 6	Distinct.	Very slight.	0.10	5.15	0.55	4.60	.0000	.0048	.02	.0100	.0000
2357	May 3	May 4	Distinct.	Sl't, earthy.	0.15	5.10	0.70	4.40	.0000	.0038	.05	.0060	.0001
Av.	....	....	....	....	0.04	7.38	0.50	6.88	.0003	.0042	.06	.0054	–

Hardness in June, 1887, 7.0; in May, 1888, 4.1. Odor, very faint or none.——The samples were collected from a faucet in the village. There were heavy showers just previous to the collection of Nos. 276 and 472.

Microscopical Examination.

April, 1888. 1. Blue-green algæ, 0.0; 2. Other algæ, pr.; 3. Fungi, 0.0; 4. Animal forms, pr.
May, 1888. 1. Blue-green algæ, 0.0; 2. Other algæ, pr.; 3. Fungi, 0.0; 4. Animal forms, 0.0.
Groups and principal genera of organisms observed: 2. Diatomaceæ. 4. Protozoa.

Chemical Examination of Water from Deep Tubular Wells, North Adams Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
692	Sept. 3	Sept. 7	Very slight.	None.	0.0	20.62	–	–	.0000	.0004	.20	.1040	–

Odor, none.——The sample was collected from a faucet. The wells had not been used for a long time until within a day, or possibly two days, of the time when the sample was collected.

Chemical Examination of Water from Broad Brook in Pownal, Vt., Proposed Source of Additional Supply for North Adams Fire District.

[Parts per 100,000.]

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.
	1887.												
3839	Jan. 10	Jan. 11	Slight.	Slight.	0.5	2.95	1.15	1.80	.0002	.0098 .0088	.03	.0100	.0001

Odor, none. —— The sample was collected from the brook at the first pole bridge, about one-half mile above the Massachusetts State line.

Microscopical Examination.

January, 1889. 1. Blue-green algæ, 0.0; 2. Other algæ, pr.; 3. Fungi, 0.0; 4. Animal forms, 0.0. Groups and principal genera of organisms observed: 2. Diatomaceæ.

Water Supply of Northampton.

Description of Works. — Population in 1885, 12,896. The works are owned by the city, and were built in 1871. The average daily consumption in 1888 was estimated to be about 1,093,000 gallons. The source of supply is Roberts' Meadow Brook in Northampton and Westhampton, on which two storage reservoirs have been built. The dam which forms the lower reservoir was built in 1871. It was rebuilt in 1879 and made two feet higher than before. The original area of the reservoir was about 3 acres and its capacity about 4,000,000 gallons. The bottom of the reservoir was cleared of all vegetable growth, and, after rebuilding the dam, a considerable portion of the bottom was excavated to a depth of three to four feet. The upper storage reservoir was built in 1883, and has a capacity of 16,500,000 gallons. Its bottom was thoroughly cleaned before filling. The watershed of Roberts' Meadow Brook above the lower storage reservoir is very hilly, and the soil is of gravel and rock. About one-third of it is wooded, and the remainder is chiefly pasture land. The area of the watershed, estimated from the new topographical map of Massachusetts, is 10.6 square miles, and it contains very few inhabitants. Water is distributed by gravity. Distributing mains are of cast iron. Enameled iron is now used for service pipes, though cement-lined, galvanized, and tarred wrought iron have been used in the past.

Chemical Examination of Water from the Upper Storage Reservoir of the Northampton Water Works on Roberts' Meadow Brook.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
405	July 25	July 27	Slight.	Consid'ble, brown.	0.85	4.45	1.07	3.38	.0017	.0219	.12	.0040	–

Odor, faintly vegetable.—— The sample was collected from the reservoir just after a rainfall of 7.16 inches.

Chemical Examination of Water from the Lower Storage Reservoir of the Northampton Water Works on Roberts' Meadow Brook.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
184	June 22	June 24	Slight.	Very slight.	0.10	4.80	0.80	4.00	.0015	.0106	.16	.0000	–
609	Aug. 23	Aug. 25	Very slight.	Sli't, brown.	0.60	4.97	1.35	3.62	.0002	.0170	.13	.0040	–

Odor, faintly vegetable.——The samples were collected from the reservoir. Sample No. 609 was collected just after a rainfall of nearly an inch.

Chemical Examination of Water from a Faucet at City Hall, Northampton, supplied from the Northampton Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
185	June 22	June 24	Decided.	Consid'ble.	0.20	5.90	1.00	4.90	.0000	.0133	.10	.0020	–
406	July 25	July 27	Slight.	Consid'ble.	0.80	4.67	1.32	3.35	.0009	.0247	.09	.0130	–
610	Aug. 23	Aug. 25	Very slight.	Very slight.	0.80	4.72	1.27	3.45	.0002	.0161	.06	.0070	–
821	Sept. 20	Sept. 21	None.	None.	0.10	4.65	0.85	3.80	.0002	.0078	.10	.0000	–
1022	Oct. 24	Oct. 25	Slight.	Slight.	0.50	5.20	1.10	4.10	.0000	.0152	.21	.0030	–
1248	Nov. 21	Nov. 23	Slight.	Very slight.	0.30	4.70	1.30	3.40	.0002	.0101	.20	.0100	–
1455	Dec. 20	Dec. 21	Slight.	Very slight.	0.15	4.05	1.00	3.05	.0004	.0095	.12	.0070	.0000

Chemical Examination of Water from a Faucet at City Hall, Northampton, supplied from the Northampton Water Works — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.	1888.											
1680	Jan. 24	Jan. 25	Very slight.	Very slight.	0.05	4.00	0.80	3.20	.0000	.0040	.06	.0000	.0000
1874	Feb. 20	Feb. 21	Very slight.	Sli't, white.	0.15	4.10	0.80	3.30	.0006	.0071	.11	.0100	.0000
2076	Mar. 20	Mar. 22	Very slight.	Sli't, brown.	0.10	3.95	0.60	3.35	.0002	.0042	.10	.0050	.0000
2252	Apr. 18	Apr. 19	Distinct.	Sli't, earthy.	0.10	2.75	0.65	2.10	.0004	.0102	.06	.0080	.0002
2480	May 21	May 22	Slight.	Con., earthy and floc't.	0.30	3.80	0.70	3.10	.0000	.0134	.06	.0040	.0000
Av.	....	....	....	....	0.30	4.37	0.95	3.42	.0003	.0113	.11	.0058	–

Hardness in May, 1888, 1.6. Odor, faintly vegetable, sometimes none. —— Sample No. 406 was collected just after a rainfall of 7.16 inches. Sample No. 610 was collected just after a rainfall of nearly an inch.

Microscopical Examination.

	1888. March.	1888. April.	1888. May.
1. Blue-green Algæ,	0.0	0.0	0.0
2. Other Algæ,	pr.	pr.	pr.
3. Fungi,	0.0	0.0	0.0
4. Animal Forms,	0.0	pr.	0.0

Groups and principal genera of organisms observed: 2. Palmellaceæ; Diatomaceæ. 4. Spongiaria.

North Andover.

Chemical Examination of Water from Great Pond, North Andover.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.	1889.											
4060	Feb. 20	Feb. 21	Slight.	Sli't, white.	0.1	3.15	0.90	2.25	.0004	.0186 .0152	.31	.0030	.0002

Odor, none. —— The sample was collected from the pond near the outlet.

Water Supply of Fire District No. 1, North Attleborough.

Description of Works. — The estimated population of the fire district in 1886 was 4,342. The total population of Attleborough and North Attleborough in 1885 was 13,175. North Attleborough was incorporated as a separate town in 1887. The works are owned by the fire district. Water was introduced in 1884. The average daily consumption in 1888 was 193,500 gallons. The source of supply is a large well near the outlet of Whiting's Mill Pond on Ten Mile River just above the village of North Attleborough. The well is 30 feet in diameter and 26 feet deep, and is covered by a roof to exclude the light. The walls are of stone lined with brick laid in cement, and the bottom is of gravel. Pumps force the water to a covered iron tank 40 feet in diameter and 60 feet in height. Distributing mains are of cast iron; service pipes are of enameled iron.

Chemical Examination of Water from the Well of the North Attleborough Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
134	June 17	June 18	None.	None.	0.0	6.90	–	–	.0000	.0006	.52	.0650	–
344	July 16	July 16	None.	None.	0.0	6.50	–	–	.0002	.0011	.51	.0130	–
556	Aug. 16	Aug. 16	None.	None.	0.0	6.60	–	–	.0003	.0006	.50	.0350	–
766	Sept. 14	Sept. 15	None.	None.	0.0	5.85	–	–	.0000	.0012	.52	.0260	–
941	Oct. 13	Oct. 13	None.	None.	0.0	5.95	–	–	.0000	.0010	.46	.0370	–
1233	Nov. 21	Nov. 22	Slight.	None.	0.0	6.60	–	–	.0000	.0031	.48	.0070	–
1400	Dec. 14	Dec. 14	None.	None.	0.0	5.55	–	–	.0000	.0000	.51	.0200	–
	1888.												
1600	Jan. 16	Jan. 17	None.	None.	0.0	5.85	–	–	.0000	.0014	.47	.0220	.0001
1791	Feb. 10	Feb. 10	Sli't, milky.	None.	0.0	6.30	–	–	.0000	.0023	.51	.0230	.0000
2004	Mar. 14	Mar. 15	Sli't, milky.	None.	0.0	5.95	–	–	.0000	.0012	.49	.0200	.0001
2224	Apr. 16	Apr. 17	Sli't, milky.	Very slight.	0.0	5.85	–	–	.0000	.0018	.50	.0230	.0000
2415	May 14	May 15	None.	None.	0.0	5.95	–	–	.0000	.0014	.50	.0300	.0000
2588	June 12	June 13	None.	None.	0.0	6.55	–	–	.0000	.0012	.49	.0400	.0000
2769	July 12	July 13	None.	None.	0.0	6.25	–	–	.0002	.0018	.50	.0150	.0000
2920	Aug. 13	Aug. 14	None.	None.	0.0	6.50	–	–	.0010	.0024	.50	.0090	.0001
3149	Sept. 10	Sept. 11	Very slight.	None.	0.0	6.15	–	–	.0008	.0014	.45	.0280	.0001
3322	Oct. 8	Oct. 9	Slight.	None.	0.0	6.30	–	–	.0000	.0028	.46	.0300	.0000
3524	Nov. 12	Nov. 12	None.	None.	0.0	6.60	–	–	.0000	.0008	.60	.0350	.0000
3684	Dec. 10	Dec. 10	None.	None.	0.0	6.95	–	–	.0006	.0026	.55	.0700	.0000

Chemical Examination of Water from the Well of the North Attleborough Water Works — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance: Turbidity.	Appearance: Sediment.	Appearance: Color.	Residue on Evaporation: Total.	Residue on Evaporation: Loss on Ignition.	Residue on Evaporation: Fixed.	Ammonia: Free.	Ammonia: Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
3844	Jan. 14	Jan. 14	None.	Very slight.	0.0	6.30	–	–	.0000	.0006	.56	.0500	.0000
4018	Feb. 14	Feb. 14	None.	None.	0.0	5.90	–	–	.0000	.0010	.57	.0450	.0000
4318	Mar. 15	Mar. 16	None.	None.	0.0	6.20	–	–	.0000	.0020	.54	.0450	.0000
4503	Apr. 12	Apr. 12	None.	None.	0.0	6.10	–	–	.0000	.0016	.52	.0220	.0000
4677	May 16	May 17	None.	None.	0.0	5.95	–	–	.0000	.0008	.56	.0450	.0000
Av.	....	....	....	....	0.0	6.23	–	–	.0001	.0014	.51	.0315	–

Hardness in May, 1888, 3.1. Odor, none. The samples were collected from a faucet at the pumping station while pumping.

Microscopical Examination.

	1888. May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	1889. Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ, . .	0.0	0.0	0.0	0.0	0.0	–	0.0	0.0	0.0	0.0	pr.	0.0	0.0
2. Other Algæ, ...	0.0	0.0	0.0	0.0	0.0	–	0.0	0.0	pr.	0.0	0.4	pr.	pr.
3. Fungi, ...	0.0	0.0	0.0	0.0	0.0	–	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, . . .	0.0	0.0	0.0	0.0	0.0	–	0.0	0.0	0.0	0.0	0.1	0.0	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ, Diatomaceæ. 3. Schizomycetes. 4. Protozoa.

Chemical Examination of Water from the Tank of the North Attleborough Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance: Turbidity.	Appearance: Sediment.	Appearance: Color.	Residue on Evaporation: Total.	Residue on Evaporation: Loss on Ignition.	Residue on Evaporation: Fixed.	Ammonia: Free.	Ammonia: Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
945	Oct. 13	Oct. 13	None.	None.	0.0	5.85	–	–	.0004	.0012	.50	.0370	–
1234	Nov. 21	Nov. 22	None.	None.	0.0	6.00	–	–	.0000	.0014	.50	.0200	–
1401	Dec. 14	Dec. 14	None.	None.	0.0	5.50	–	–	.0000	.0012	.49	.0200	–
	1888.												
1599	Jan. 16	Jan. 17	None.	None.	0.0	5.65	–	–	.0000	.0014	.48	.0300	.0000
1792	Feb. 10	Feb. 10	None.	None.	0.0	5.95	–	–	.0000	.0010	.51	.0250	.0000
2003	Mar. 14	Mar. 15	None.	None.	0.0	5.70	–	–	.0000	.0014	.50	.0250	.0000
2589	June 12	June 13	None.	None.	0.0	6.25	–	–	.0000	.0010	.51	.0500	.0000

Chemical Examination of Water from the Tank of the North Attleborough Water Works — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
2768	July 12	July 13	None.	None.	0.0	5.85	–	–	.0002	.0016	.50	.0400	.0000
2921	Aug. 13	Aug. 14	None.	None.	0.0	6.15	–	–	.0006	.0032	.54	.0250	.0000
3150	Sept. 10	Sept. 11	None.	None.	0.0	5.90	–	–	.0010	.0026	.52	.0350	.0000
3323	Oct. 8	Oct. 9	Very slight.	None.	0.0	6.00	–	–	.0000	.0022	.46	.0500	.0000
3685	Dec. 10	Dec. 10	None.	None.	0.0	6.05	–	–	.0002	.0016	.51	.0650	.0000
	1889.												
4756	May 31	June 1	Sli't, milky.	Consid'ble.	0.0	6.00	–	–	.0010	.0044	.52	.0500	.0001
Av.	....	....	....	....	0.0	5.91	–	–	.0003	.0019	.50	.0363	–

Odor, none. —— The samples were collected from a faucet in a house on the main pipe leading from the tank. Samples numbered 1234, 1401, 1599, 1792, 2003, 3323 and 3685 were collected from 40 to 42 hours after pumping had ceased. Those numbered 945, 2589, and 2768 were collected from 18 to 22 hours after pumping had ceased. No. 4756 was collected from a faucet at the dead end of a 6-inch main 48 hours after pumping had ceased.

Microscopical Examination.

	1888. June.	1888. July.	1888. Aug.	1888. Sept.	1888. Oct.	1888. Dec.	1889. May.
1. Blue-green Algæ,	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ,	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3. Fungi,	0.0	0.2	0.0	0.0	2.5	0.0	120.0
4. Animal Forms,	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Groups and principal genera of organisms observed: 3. Schizomycetes, *Leptothrix*, *Crenothrix*. All of the organisms found in May, 1889, were of the genus *Crenothrix*.

Chemical Examination of Water from the Ten Mile River at North Attleborough.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
943	Oct. 13	Oct. 13	Distinct.	Sli't, white.	0.30	3.65	0.55	3.10	.0000	.0219	.36	.0000	–
1399	Dec. 14	Dec. 14	Slight.	Very slight, white.	0.10	3.85	0.85	3.00	.0020	.0130	.40	.0150	–
	1888.												
1598	Jan. 16	Jan. 17	None.	Very slight.	0.20	3.75	0.75	3.00	.0028	.0089	.26	.0250	.0001
1790	Feb. 10	Feb. 10	Slight.	None.	0.10	2.90	0.90	2.00	.0045	.0174	.19	.0150	.0000

Chemical Examination of Water from the Ten Mile River at North Attleborough — Concluded.

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.
	1888.												
2002	Mar. 14	Mar. 15	Slight.	Very slight.	0.05	2.65	0.35	2.30	.0014	.0100	.32	.0100	.0001
2225	Apr. 16	Apr. 17	Slight.	Very slight.	0.20	2.85	0.65	2.20	.0003	.0112	.29	.0080	.0001
2414	May 14	May 15	Distinct.	Very slight.	0.25	3.50	0.95	2.55	.0004	.0256	.30	.0050	.0002
2587	June 12	June 13	Distinct.	Con., white.	0.15	3.78	0.95	2.83	.0000	.0242 .0170	.31	.0070	.0003
2767	July 12	July 13	Very slight.	Sli't, brown.	0.10	3.30	1.05	2.25	.0004	.0186 .0148	.31	.0000	.0000
2919	Aug. 13	Aug. 14	Slight.	Sli't, brown.	0.10	3.50	1.00	2.50	.0012	.0124 .0114	.35	.0030	.0001
3148	Sept. 10	Sept. 11	Slight.	Very slight.	0.15	2.95	0.70	2.25	.0016	.0136 .0114	.27	.0050	.0002
3321	Oct. 8	Oct. 9	Distinct.	Sli't, white.	0.10	3.55	1.10	2.45	.0002	.0134 .0114	.30	.0120	.0002
3523	Nov. 12	Nov. 12	Distinct.	Slight.	0.20	3.30	0.80	2.50	.0000	.0110 .0082	.32	.0150	.0000
3728	Dec. 17	Dec. 17	Very slight.	Very slight.	0.15	3.15	0.90	2.25	.0008	.0080 .0078	–	.0180	.0002
	1889.												
3843	Jan. 14	Jan. 14	Very slight.	Very slight.	0.10	2.65	0.60	2.05	.0004	.0050 .0042	.29	.0150	.0002
4017	Feb. 14	Feb. 14	Very slight.	None.	0.10	2.70	0.50	2.20	.0018	.0070 .0052	.32	.0120	.0000
4317	Mar. 15	Mar. 16	Slight.	Very slight.	0.10	2.65	0.70	1.95	.0000	.0102 .0086	.27	.0100	.0002
4502	Apr. 12	Apr. 12	Distinct.	Slight.	0.10	2.75	0.75	2.00	.0010	.0144 .0092	.27	.0040	.0003
4676	May 16	May 17	Slight.	Slight.	0.10	3.15	0.80	2.35	.0000	.0180 .0160	.27	.0030	.0000
Av.	....	....	....	....	0.14	3.31	0.71	2.60	.0010	.0139	.30	.0096	.0001

Hardness in May, 1888, 1.7. Odor, distinctly vegetable, seldom mouldy. ——The samples were collected from Whiting's Mill Pond at the dam near the well of the North Attleborough Water Works.

Microscopical Examination.

	1888.							1889.				
	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ, ...	0.0	pr.	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	pr.	0.0
2. Other Algæ, ...	2.0	2.0	0.6	1.0	pr.	0.1	pr.	0.1	0.6	0.9	0.2	0.1
3. Fungi, ...	0.0	0.2	pr.	0.5	0.0	0.0	0.0	0.0	pr.	0.0	0.0	0.0
4. Animal Forms, ...	0.3	0.0	pr.	0.4	0.0	0.0	pr.	0.2	0.0	pr.	0.3	0.3

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Synedra*. 3. Schizomycetes. 4. Protozoa; Rotifera; Entomostraca.

Water Supply of Northborough.

Description of Works. — Population in 1885, 1,883. The works are owned by the town, and were built in 1882. There were about 200 water takers in 1887. The source of supply is Cold Harbor Brook in Shrewsbury, on which a storage reservoir is built. The area of the reservoir is about 9 acres and its capacity about 30,000,000 gallons. Its maximum depth is 15 feet. The bottom is muddy, and portions of the reservoir are quite shallow. The watershed contains a very small population. Water is distributed by gravity. Distributing mains are of wrought iron lined with cement; service pipes are of enameled iron. In 1886 and 1887 there were complaints that the water supplied to consumers had a disagreeable taste and odor.

Chemical Examination of Water from a Faucet in Northborough supplied from the Northborough Water Works.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1887.												
99	June 14	June 15	Slight.	Consid'ble.	1.10	4.47	2.20	2.27	.0014	.0234	.19	.0130	–
312	July 12	July 13	Very slight.	Slight.	0.90	5.40	1.87	3.53	.0038	.0306	.15	.0070	–
525	Aug. 11	Aug. 12	Decided.	Consid'ble.	1.40	6.17	2.47	3.70	.0008	.0395	.20	.0000	–
745	Sept. 12	Sept. 13	Decided.	Consid'ble.	1.40	5.37	1.67	3.70	.0018	.0296	.20	.0230	–
953	Oct. 13	Oct. 14	Distinct.	Con., earthy and floc't.	1.30	5.10	1.65	3.45	.0006	.0224	.24	.0080	–
1154	Nov. 10	Nov. 11	Decided.	Consid'ble.	0.90	4.85	1.35	3.50	.0004	.0299	.24	.0050	–
1398	Dec. 14	Dec. 14	Distinct.	Sli't, white.	1.10	4.70	1.50	3.20	.0006	.0201	.23	.0000	–
	1888.												
1620	Jan. 18	Jan. 19	None.	Very slight.	0.50	3.80	1.30	2.50	.0023	.0131	.12	.0080	–
1831	Feb. 14	Feb. 15	Very slight.	Very slight.	0.55	4.00	1.30	2.70	.0021	.0125	.20	.0180	.0000
2016	Mar. 15	Mar. 16	Slight.	Slight.	0.30	3.30	0.75	2.55	.0026	.0138	.15	.0080	.0001
2250	Apr. 18	Apr. 19	Very slight.	Very slight, white.	0.30	2.45	0.85	1.60	.0009	.0131	.14	.0080	.0001
2436	May 16	May 17	Distinct.	Consid'ble.	0.70	3.55	1.75	1.80	.0002	.0222	.13	.0050	.0000
3222	Sept. 19	Sept. 20	Slight.	Consid'ble.	0.50	3.85	1.30	2.55	.0002	.0316 .0212	.23	.0030	.0001
3383	Oct. 17	Oct. 18	Very slight.	Slight.	1.00	3.70	1.40	2.30	.0002	.0200 .0182	.19	.0070	.0002
Av.	....	....	....	....	0.85	4.43	1.56	2.87	.0013	.0230	.19	.0081	.0001

Hardness in May, 1888, 1.4. Odor, faintly vegetable, sometimes mouldy. —— The samples were collected from a faucet in the village. There were heavy rains just previous to the collection of 525 and 3383.

Microscopical Examination.

	1888.		
	May.	Sept.	Oct.
1. Blue-green Algæ,	pr.	pr.	0.0
2. Other Algæ,	pr.	38.6	1.5
3. Fungi,	0.0	pr.	0.0
4. Animal Forms,	0.0	2.8	0.4

Groups and principal genera of organisms observed: 1. Cyanophyceæ, *Merismopedia.* 2. Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Asterionella, Synedra.* 3. Schizomycetes. 4. Protozoa, *Peridinium, Trachelomonas;* Rotifera.

Water Supply of Northbridge.—Whitin Machine Works.

Description of Works. — The population of the town of Northbridge in 1885 was 3,786. The works are owned by the Whitin Machine Company, and were constructed in 1889 to supply the village of Whitinsville, which had a population in 1880 of 2,340. The sources of supply are springs, the water from which is collected in vitrified drain pipes laid in trenches and covered with broken stone, and, at the top, with earth. The pipes conduct the water to a reservoir 74 feet long, 42 feet wide and 10 feet deep. The reservoir is covered by a roof. Water is distributed by gravity. Distributing mains are of cast iron; service pipes are of wrought iron. No analyses of the water have been made.

North Reading.

Chemical Examination of Water from Martin's Pond in North Reading.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
290	July 8	July 9	Very slight.	None.	1.7	4.33	1.65	2.68	.0011	.0327	.15	.0000	–
	1888.												
2311	Apr. 26	Apr. 27	Distinct.	Sli't, black.	0.7	2.75	1.40	1.35	.0008	.0216	.22	.0040	.0001

Odor, faintly vegetable.——The samples were collected near the south shore of the pond. The city of Malden has authority to take the water of this pond for a public water supply.

Microscopical Examination.

April, 1888. 1. Blue-green algæ, 0.0; 2. Other algæ, pr.; 3. Fungi, 0.0; 4. Animal forms, pr.

Groups and principal genera of organisms observed: 2. Palmellaceæ; Diatomaceæ. 4. Entomostraca.

Water Supply of Norwood.

Description of Works. — Population in 1885, 2,921. The works are owned by the town. Water was introduced in 1885. The average daily consumption in 1888 was 150,000 gallons. The source of supply is Buckmaster Pond in Dedham, near the line between Dedham and Norwood. The area of the pond at high water is 29.5 acres, and when drawn down 6 feet its area is 22 acres. Its capacity is 123,000,000 gallons. The maximum depth of the pond is 29 feet at high water; the average depth is 13 feet. The bottom of the pond is of sand and gravel except at the northerly end, opposite the outlet, where there is a layer of mud. The watershed, which has an area of about 250 acres, is mainly wood and pasture land, and contains a small population. The area is somewhat hilly and the soil is gravelly. Pumps force the water from the pond to an open distributing reservoir and to the village. The reservoir is located between the pond and the village, about 500 feet from the main pipe, and is connected with the latter by a single line of pipe. The dimensions of the reservoir are as follows: At inside top of the embankment, 161.5 feet long and 141.8 feet wide; at the bottom, 104.5 feet long and 84.8 feet wide. At high-water mark it is 14 feet deep, and its capacity is about 1,400,000 gallons. The bottom is covered with a layer of concrete six inches in thickness, and the slopes are paved. Distributing mains are of cast iron. Service pipes are of wrought iron coated with tar.

The town also obtained the right to take the waters of Foundry and Coleman's brooks at the time of taking Buckmaster Pond.

Chemical Examination of Water from Buckmaster Pond in Dedham.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1887.												
127	June 16	June 17	Slight.	Slight.	0.10	2.95	1.72	1.23	.0009	.0133	.23	.0000	–
355	July 18	July 19	Very slight.	None.	0.10	2.65	0.90	1.75	.0020	.0226	.28	.0040	–
538	Aug. 15	Aug. 15	Slight.	Very slight, white.	0.20	2.65	1.02	1.63	.0004	.0213	.33	.0000	–
992	Oct. 19	Oct. 20	Slight.	Slight.	0.05	2.50	0.75	1.75	.0000	.0250	.28	.0000	–
1184	Nov. 14	Nov. 15	Slight.	Sli't, white.	0.10	2.45	1.10	1.35	.0122	.0228	.32	.0030	–
1408	Dec. 14	Dec. 15	Very slight.	Sli't, white.	0.00	2.65	0.85	1.80	.0191	.0224	.33	.0040	–

Chemical Examination of Water from Buckmaster Pond in Dedham — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
1585	Jan. 12	Jan. 13	Slight.	Very slight.	0.10	2.80	0.95	1.85	.0184	.0235	.39	.0090	.0001
1794	Feb. 10	Feb. 11	Very slight.	Very slight, white.	0.10	3.10	1.20	1.90	.0228	.0393	.34	.0100	.0001
2007	Mar. 13	Mar. 15	Sli't, milky.	Slight.	0.30	2.55	0.65	1.90	.0073	.0228	.26	.0100	.0005
2202	Apr. 12	Apr. 13	Decided.	Very slight.	0.15	2.70	1.00	1.70	.0087	.0216	.26	.0080	.0003
2399	May 10	May 11	Distinct.	Sli't, white.	0.20	3.10	1.00	2.10	.0022	.0248	.29	.0050	.0001
2659	June 25	June 26	Distinct.	Very slight, white.	0.20	2.60	0.90	1.70	.0006	.0226 .0192	.28	.0050	.0000
2778	July 16	July 17	Slight.	Very slight.	0.10	2.35	0.85	1.50	.0000	.0250 .0214	.29	.0020	.0001
3146	Sept. 10	Sept. 11	Slight.	Very slight.	0.10	2.30	0.95	1.35	.0020	.0258 .0206	.24	.0030	.0002
3368	Oct. 15	Oct. 16	Slight.	Very slight, white.	0.10	2.45	0.90	1.55	.0038	.0206 .0182	.26	.0060	.0000
3550	Nov. 14	Nov. 15	Slight.	Sli't, white.	0.10	2.65	1.10	1.55	.0030	.0220 .0200	.26	.0070	.0000
	1889.												
3799	Jan. 2	Jan. 2	Very slight.	Very slight.	0.15	2.10	0.75	1.35	.0048	.0158 .0148	.29	.0120	.0004
3845	Jan. 14	Jan. 15	Very slight.	Very slight.	0.15	2.30	0.65	1.65	.0028	.0152 .0142	.30	.0070	.0004
4012	Feb. 12	Feb. 13	Very slight.	Very slight, earthy.	0.15	2.90	0.70	2.20	.0038	.0250 .0220	.35	.0120	.0002
4287	Mar. 12	Mar. 13	Very slight.	Very slight.	0.20	2.60	0.75	1.85	.0038	.0162 .0142	.29	.0120	.0001
4482	Apr. 9	Apr. 10	Very slight.	Very slight.	0.10	2.45	0.80	1.65	.0008	.0172 .0150	.30	.0100	.0000
4621	May 7	May 8	Slight.	Slight.	0.10	2.20	1.00	1.20	.0026	.0186 .0164	.26	.0050	.0002
Av.	....	....	....	....	0.13	2.74	1.01	1.73	.0055	.0220	.29	.0061	.0002

Hardness in May, 1888, 0.8. Odor, faintly vegetable, often mouldy. —— The samples were collected from the pond. The pond was very low when No. 1408 was collected.

Microscopical Examination.

	1888. June.	1888. July.	1888. Sept.	1888. Oct.	1888. Nov.	1889. Jan.	1889. Jan.	1889. Feb.	1889. Mar.	1889. Apr.	1889. May.
1. Blue-green Algæ, ...	pr.	0.0	pr.	pr.	pr.	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	0.1	0.2	1.8	2.3	0.0	0.5	0.0	pr.	0.7	0.0	0.4
3. Fungi, ...	pr.	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, ...	0.1	0.5	3.1	1.5	8.0	0.5	0.0	0.5	pr.	pr.	0.2

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ, *Chlorococcus;* Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Asterionella;* Zygnemaceæ; Volvocineæ. 3. Schizomycetes. 4. Protozoa, *Dinobryon*, *Peridinium;* Spongiaria; Rotifera; Entomostraca.

Chemical Examination of Water from the Distributing Reservoir of the Norwood Water Works.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.		Nitrates.	Nitrites.
	1887.												
126	June 16	June 17	Distinct.	None.	0.10	2.80	1.27	1.53	.0008	.0148	.33	.0000	–
356	July 18	July 19	Very slight.	None.	0.10	2.55	1.00	1.55	.0011	.0196	.29	.0000	–
539	Aug. 15	Aug. 15	Slight.	None.	0.20	2.85	1.02	1.83	.0012	.0198	.30	.0000	–
993	Oct. 19	Oct. 20	Slight.	Sli't, white.	0.05	2.40	0.85	1.55	.0000	.0236	.31	.0000	–
1185	Nov. 14	Nov. 15	Slight.	Sli't, white.	0.05	2.45	1.00	1.45	.0056	.0233	.31	.0030	–
1409	Dec. 14	Dec. 15	Slight.	Sli't, white.	0.00	2.60	0.85	1.75	.0144	.0240	.33	.0040	–
	1888.												
1586	Jan. 12	Jan. 13	Very slight.	Very slight.	0.10	2.60	1.05	1.55	.0182	.0210	.35	.0080	.0001
1795	Feb. 10	Feb. 11	Very slight.	Very slight, white.	0.10	3.10	1.10	2.00	.0218	.0274	.34	.0080	.0001
2008	Mar. 13	Mar. 15	Slight.	Slight.	0.00	2.40	0.70	1.70	.0094	.0204	.29	.0100	.0001
2203	Apr. 12	Apr. 13	Distinct.	Very slight.	0.15	2.55	0.80	1.75	.0062	.0214	.29	.0100	.0004
2400	May 10	May 11	Distinct.	Very slight.	0.20	2.35	1.20	1.15	.0028	.0184	.27	.0080	.0001
3002	Aug. 21	Aug. 22	Very slight.	Very slight.	0.10	3.45	1.25	2.20	.0018	.0208 .0172	.24	.0000	.0003
Av.	....	....	....	....	0.10	2.60	0.99	1.61	.0069	.0212	.30	.0043	.0002

Hardness in May, 1888, 1.1. Odor, faintly vegetable, often mouldy.—— The samples were collected from the reservoir.

Microscopical Examination.

	1889.		
	April.	May.	Aug.
1. Blue-green Algæ, ...	0.0	0.0	pr.
2. Other Algæ, ...	pr.	pr.	0.6
3. Fungi, ...	0.0	0.0	0.0
4. Animal Forms, ...	pr.	pr.	pr.

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ; Zygnemaceæ. 4. Protozoa; Entomostraca.

Chemical Examination of Water from a Faucet in Norwood, supplied from the Norwood Water Works.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1887.												
735	Sept. 12	Sept. 13	Slight.	Very slight.	0.05	2.57	0.70	1.87	.0036	.0166	.33	.0100	-
	1888.												
3687	Dec. 10	Dec. 11	Very slight.	None.	0.05	2.85	1.05	1.80	.0042	.0172 .0160	.29	.0050	.0003

Odor, none. —— The samples were collected from a faucet in the village of Norwood.

Microscopical Examination.

December, 1888. 1. Blue-green algæ, 0.0; 2. Other algæ, 0.5; 3. Fungi, 0.0; 4. Animal forms, 0.5. Groups and principal genera of organisms observed: 2. Diatomaceæ; Desmidiaceæ. 4. Protozoa.

Water Supply of Orange. — New Home Sewing Machine Company.

Description of Works. — Population in 1885, 3,650. The works are owned by the New Home Sewing Machine Company, and were built in 1873. About 100 families were supplied in 1887. The source of supply is a spring, the water of which is stored in two very small reservoirs. The larger one has an area of about one-fourth of an acre and a depth of 8 feet. Water flows from this into the smaller reservoir, which is 30 feet square and 12 feet deep. Water is distributed by gravity. Distributing mains are of wrought iron lined with cement. Service pipes are of lead and wrought iron. In dry weather this supply is supplemented by pumping from Miller's River with a pump in the works of the Sewing Machine Company.

Chemical Examination of Water from the Spring of the New Home Sewing Machine Company, Orange.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1887.												
1186	Nov. 14	Nov. 15	None.	Very slight.	0.05	3.10	0.55	2.55	.0000	.0075	.10	.0030	-

Odor, none. —— The sample was collected from a faucet in the village.

Water Supply of Palmer Fire District, Palmer. — Palmer Water Company.

Description of Works. — Population of the town of Palmer in 1885, 5,923. The works are owned by the Palmer Water Company, and were completed in 1886. About 175 families were supplied in 1887. The source of supply is a small brook in Palmer, on which two storage reservoirs are built. The upper one is the larger and has an area of about four acres. Its maximum depth is 15 feet and its capacity is 6,000,000 gallons. The lower reservoir is a very short distance below the upper one, and is smaller. Its area is about three-fourths of an acre and its capacity about 2,000,000 gallons; its general depth is 4 or 5 feet. The bottom and sides of both reservoirs are covered with sand. The drainage area is steep and consists of pasture and woodland. Distributing mains are of wrought iron lined with cement. Service pipes are of lead.

Chemical Examination of Water from a Faucet in Palmer, supplied from the Works of the Palmer Water Company.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1887.												
125	June 16	June 17	Very slight, milky.	Sli't, brown.	0.10	4.30	0.95	3.35	.0007	.0068	.13	.0000	–
361	July 19	July 20	Very slight.	None.	0.10	4.37	0.82	3.55	.0005	.0104	.13	.0000	–
559	Aug. 16	Aug. 17	Very slight.	Very slight.	0.40	4.37	0.80	3.57	.0000	.0095	.11	.0000	–
759	Sept. 13	Sept. 14	Slight.	None.	0.05	3.95	0.70	3.25	.0013	.0080	.13	.0030	–
1188	Nov. 14	Nov. 15	Very slight.	Very slight.	0.10	3.85	0.70	3.15	.0004	.0064	.15	.0030	–
1413	Dec. 15	Dec. 16	None.	Very slight.	0.30	4.85	0.75	4.10	.0004	.0076	.16	.0040	.0000
	1888.												
1608	Jan. 16	Jan. 17	Very slight.	None.	0.10	3.45	0.55	2.90	.0002	.0030	.10	.0180	.0000
1832	Feb. 14	Feb. 15	Very slight.	Slight.	0.10	3.20	0.65	2.55	.0000	.0044	.12	.0120	.0000
2050	Mar. 19	Mar. 20	Very slight.	None.	0.20	3.10	0.30	2.80	.0007	.0060	.13	.0080	.0001
2227	Apr. 16	Apr. 17	Very slight.	None.	0.10	2.85	0.55	2.30	.0005	.0096	.12	.0060	.0001
2479	May 21	May 22	Distinct.	Con., rusty brown.	0.50	4.60	1.25	3.35	.0000	.0240	.09	.0050	.0000
Av.	....	....	....	....	0.19	3.90	0.73	3.17	.0004	.0087	.12	.0054	.0000

Hardness in May, 1888, 1.3. Odor, very faint or none.——The samples were collected from a faucet in the village of Palmer. Sample No. 2479 was collected just after a heavy rain.

Microscopical Examination.

	1888.		
	March.	April.	May.
1. Blue-green Algæ,	0.0	0.0	0.0
2. Other Algæ,	pr.	pr.	pr.
3. Fungi,	0.0	0.0	0.0
4. Animal Forms,	pr.	pr.	0.0

Groups and principal genera of organisms observed: 2. Diatomaceæ. 4. Protozoa.

Water Supply of Peabody.

Description of Works. — Population in 1885, 9,530. The works are owned by the town. Water was first introduced in 1799 by the Salem and Danvers Aqueduct Company, the supply at first being taken from springs and afterwards from Spring and Brown's ponds, which are the present sources. The town of Peabody purchased the works in 1873. The average daily consumption from the high-service works in 1888 was about 688,000 gallons; that from the low-service works was about 300,000 gallons.

Brown's Pond is located in Peabody. Spring Pond is in Peabody and Salem. Both ponds are natural, and have sand or gravel bottoms. The combined watersheds of the ponds have an area of about 550 acres, as estimated from the new topographical map of Massachusetts, and consist of woodland with a little cultivated land. The region is hilly, and contains but few inhabitants. Water flows from the ponds into two small basins or reservoirs, from the lower one of which the supply for the town is drawn. The town was formerly supplied entirely by gravity, but the larger portion is now supplied by pumping. Water is forced by the pumps to an iron tank, open at the top, 60 feet in diameter and 25 feet in height. Distributing mains are of wrought iron lined with cement. Service pipes are of lead. There has been at times a bad taste and odor in the water supplied to consumers.

Chemical Examination of Water from Brown's Pond, Peabody.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
164	June 21	June 22	Slight.	None.	0.20	3.27	1.47	1.80	.0000	.0128	.47	.0000	–
384	July 21	July 22	Slight.	Very slight.	0.00	2.87	0.72	2.15	.0000	.0210	.48	.0040	–
600	Aug. 22	Aug. 23	Very slight.	None.	0.30	2.85	0.97	1.88	.0002	.0169	.40	.0000	–
Av.	....	....	....	....	0.17	3.00	1.05	1.95	.0001	.0169	.45	–	–

Odor, none or faintly vegetable.—— The samples were collected from the pond near the outlet.

Chemical Examination of Water from Spring Pond, Peabody.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
163	June 21	June 22	Very slight.	None.	0.0	4.22	1.40	2.82	.0000	.0090	.65	.0000	–
383	July 21	July 22	Very slight.	Very slight.	0.0	3.85	0.60	3.25	.0001	.0110	.67	.0000	–
601	Aug. 22	Aug. 23	Very slight.	None.	0.0	3.67	0.60	3.07	.0003	.0133	.57	.0000	–
Av.	....	....	....	....	0.0	3.91	0.87	3.04	.0001	.0111	.63	.0000	–

Odor, none or faintly vegetable.—— The samples were collected from the pond near the outlet.

Chemical Examination of Water from the Lower Basin, Peabody Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
165	June 21	June 22	Very slight.	None.	0.00	4.37	1.40	2.97	.0014	.0133	.61	–	–
382	July 21	July 22	Very slight.	None.	0.00	4.52	0.80	3.72	.0010	.0135	.68	.0330	–
602	Aug. 22	Aug. 23	Very slight.	None.	0.05	4.40	0.72	3.68	.0002	.0099	.57	.0330	–
819	Sept. 20	Sept. 21	None.	None.	0.00	4.55	0.65	3.90	.0000	.0120	.61	.0390	–
994	Oct. 20	Oct. 20	Very slight.	Very slight.	0.00	4.50	0.50	4.00	.0002	.0086	.63	.0390	–
1200	Nov. 16	Nov. 16	Very slight.	None.	0.00	4.35	1.15	3.20	.0006	.0082	.60	.0090	–
1436	Dec. 19	Dec. 19	Distinct.	Very slight.	0.00	4.80	1.30	3.50	.0004	.0088	.65	.0450	–

Chemical Examination of Water from the Lower Basin, Peabody Water Works — Concluded.

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.		Nitrates.	Nitrites.
	1888.												
1612	Jan. 17	Jan. 17	Slight.	None.	0.00	4.85	0.85	4.00	.0000	.0076	.66	.0330	.0002
1824	Feb. 14	Feb. 15	Very slight.	None.	0.00	4.70	0.90	3.80	.0002	.0076	.70	.0420	.0001
2058	Mar. 20	Mar. 21	Very slight.	Very slight.	0.10	4.10	0.60	3.50	.0000	.0098	.56	.0400	.0002
2236	Apr. 17	Apr. 18	Distinct.	Very slight.	0.05	3.65	0.80	2.85	.0004	.0132	.55	.0230	.0003
2430	May 15	May 16	Distinct.	Slight.	0.10	3.45	0.30	3.15	.0018	.0150	.53	.0150	.0001
Av.	....	....	....	....	0.03	4.35	0.83	3.52	.0005	.0106	.61	.0319	.0002

Hardness in May, 1888, 1.8. Odor, faintly vegetable or mouldy.—— The samples were collected from a faucet at the pumping station.

Microscopical Examination.

	1888.		
	March.	April.	May.
1. Blue-green Algæ,	0.0	0.0	0.0
2. Other Algæ,	pr.	pr.	pr.
3. Fungi,	0.0	0.0	0.0
4. Animal Forms,	pr.	pr.	pr.

Groups and principal genera of organisms observed: 2. Palmellaceæ; Diatomaceæ. 4. Protozoa; Rotifera.

PHILLIPSTON.

Chemical Examination of Water from Phillipston Pond, in Phillipston.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.		Nitrates.	Nitrites.
	1887.												
890	Oct. 5	Oct. 6	Very slight.	Sli't, white.	0.1	2.03	0.82	1.21	.0000	.0138	.12	.0020	–
1254	Nov. 25	Nov. 26	Very slight.	Very slight.	0.1	2.45	0.95	1.50	.0008	.0163	.14	.0020	–

Odor, faintly vegetable.—— Sample No. 890 was collected from near the middle of the pond about 6 inches beneath the surface. Sample No. 1254 was collected from the pond at its outlet.

Water Supply of Pittsfield Fire District, Pittsfield.

Description of Works. — Population of the town of Pittsfield in 1885, 14,466. The works are owned by the Fire District, and were built in 1855. About 10,000 people were supplied in 1887. The sources of supply are Sackett and Ashley brooks, on each of which a small reservoir is built, and Ashley Lake, situated near the head of Ashley Brook. Ashley Lake is a natural pond, but its area and storage capacity have been increased by a dam at the outlet. Its present area is 80 acres. The watershed of the lake is small in comparison with the storage capacity, so that if the lake is drawn down to low-water mark in the fall or winter it may not always fill in the spring. Water flows from Ashley Lake to Ashley Reservoir in the natural channel of a brook, and falls 800 feet in the total distance, which is about 2½ miles. The main pipes leading to the town start from Ashley Reservoir, and a pipe from Sackett Reservoir, which is at a somewhat greater elevation, is connected with these mains. The area of the watershed of Ashley Reservoir is 2.82 square miles; that of Sackett Reservoir is 2.57 square miles, making the total watershed now supplying Pittsfield 5.39 square miles. These areas were estimated from the new topographical map of Massachusetts. The watersheds are mountainous and uninhabited. The main pipes were originally of wrought iron lined with cement, but for several years cast iron has been used for extensions and renewals.

Chemical Examination of Water from Ashley Lake, Pittsfield Water Works.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1887.												
50	June 6	June 8	Slight.	Consid'ble.	0.20	3.40	1.40	2.00	.0046	.0182	.07	.0030	–
289	July 7	July 9	Slight.	Very slight.	0.40	3.52	1.30	2.22	.0010	.0177	.07	.0000	–
591	Aug. 21	Aug. 23	Very slight.	None.	0.40	4.10	1.35	2.75	.0013	.0199	.16	.0030	–
685	Sept. 5	Sept. 6	Very slight.	Very slight.	0.40	3.62	1.60	2.02	.0002	.0202	.05	.0070	–
1100	Nov. 2	Nov. 4	Very slight.	Slight.	0.40	3.60	1.45	2.15	.0022	.0282	.08	.0050	–
1338	Dec. 5	Dec. 7	Slight.	Slight.	0.45	3.35	1.35	2.00	.0055	.0183	.08	.0020	–
	1888.												
2354	May 3	May 4	Slight.	Very slight.	0.10	2.00	1.10	0.90	.0036	.0112	.06	.0080	.0001
Av.	....	....	....	....	0.34	3.37	1.36	2.01	.0026	.0191	.08	.0040	–

Hardness in May, 1888, 0.3. Odor, faintly vegetable. —— The samples were collected from the lake. There were heavy rains just previous to the collection of Nos. 591 and 1338. No water was drawn from the lake for use in the town during the summer of 1887, and the lake remained full most of the time.

Microscopical Examination.

May, 1888. 1. Blue-green algæ, 0.0; 2. Other algæ, pr.; 3. Fungi, 0.0; 4. Animal forms, pr. Groups and principal genera of organisms observed: 2. Palmellaceæ; Diatomaceæ. 4. Protozoa.

Chemical Examination of Water from Ashley Reservoir, Pittsfield Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
592	Aug. 21	Aug. 23	None.	Very slight.	0.30	6.92	0.97	5.95	.0000	.0126	.03	.0070	–
1340	Dec. 5	Dec. 7	Very slight.	Very slight.	0.10	6.50	1.25	5.25	.0011	.0101	.07	.0100	–
	1888.												
2355	May 3	May 4	Very slight.	Very slight.	0.15	4.20	0.90	3.30	.0004	.0194	.10	.0100	.0001
Av.	....	....	....	....	0.18	5.87	1.04	4.83	.0005	.0140	.07	.0090	–

Hardness in May, 1888, 3.2. Odor, faintly vegetable.—— Samples numbered 1340 and 2355 were collected from the reservoir. Sample No. 592 was collected from a faucet supplied from the reservoir.

Microscopical Examination.

May, 1888. 1. Blue-green algæ, 0.0; 2. Other algæ, pr.; 3. Fungi, 0.0; 4. Animal forms, 0.0. Groups and principal genera of organisms observed: 2. Diatomaceæ.

Chemical Examination of Water from Sackett Reservoir, Pittsfield Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
45	June 6	June 8	Very slight.	Con., rusty.	0.00	7.57	1.80	5.77	.0005	.0093	.07	.0130	–
684	Sept. 5	Sept. 6	Very slight.	Very slight.	0.00	6.80	0.45	6.35	.0010	.0048	.08	.0130	–
904	Oct. 7	Oct. 8	None.	Very slight.	0.20	7.80	1.00	6.80	.0003	.0082	.06	.0090	–
1101	Nov. 2	Nov. 4	None.	Very slight.	0.00	6.70	1.00	5.70	.0000	.0028	.09	.0100	–
1339	Dec. 5	Dec. 7	Slight.	Sli't, earthy and floc't.	0.30	5.90	1.10	4.80	.0019	.0144	.10	.0120	–
	1888.												
2356	May 3	May 4	None.	None.	0.15	4.75	0.95	3.80	.0000	.0066	.07	.0100	.0000
Av.	....	....	....	....	0.11	6.59	1.05	5.54	.0006	.0077	.08	.0112	–

Hardness in May, 1888, 3.2. Odor, very faint or none.—— Samples numbered 684, 1101, and 1339 were collected from Sackett Reservoir. Samples numbered 45, 904 and 2356 were collected from a faucet in the town.

Microscopical Examination.

May, 1888. 1. Blue-green algæ, 0.0; 2. Other algæ, pr.; 3. Fungi, 0 0; 4. Animal forms, 0.0. Groups and principal genera of organisms observed: 2. Diatomaceæ.

Chemical Examination of Water from a Faucet, supplied from Sackett and Ashley Reservoirs, Pittsfield Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
250	July 5	July 6	None.	Slight.	0.05	6.25	1.30	4.95	.0008	.0070	.12	.0070	-
1102	Nov. 2	Nov. 4	None.	None.	0.00	6.80	1.00	5.80	.0000	.0024	.07	.0120	-

Odor, none.——The samples were collected from a faucet in the village, sometimes supplied from Sackett Reservoir, sometimes from Ashley Reservoir, and sometimes from both.

Chemical Examination of Water from Lake Onota, Pittsfield.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
3115	Sept. 7	Sept. 8	Very slight.	Very slight.	0.0	6.60	1.45	5.15	.0000	.0158 .0110	.03	.0030	.0000

Odor, none.——The sample was collected from the east side of the lake.

Chemical Examination of Water from Pontoosuc Lake, Pittsfield.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
3123	Sept. 7	Sept. 8	Very slight.	Very slight.	0.0	7.90	0.80	7.10	.0006	.0128 .0122	.04	.0000	.0000

Odor, none.——The sample was collected from the lake at the outlet.

Chemical Examination of Water from Silver Lake, Pittsfield.

[Parts per 100,000.]

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.
	1888.	1888.											
3540	Nov. 13	Nov. 14	Distinct, milky.	Con., e'rthy.	0.05	23.25	4.90	18.35	.0024	.0490 .0440	.37	.1600	.0007
	1889.	1889.											
4015	Feb. 12	Feb. 13	Very slight.	Very slight.	0.05	16.85	2.70	14.15	.0142	.0124 .0074	.46	.1100	.0016
4016	Feb. 12	Feb. 13	Very slight.	Very slight.	0.05	17.25	2.30	14.95	.0124	.0146 .0068	.44	.1400	.0017

Odor, faintly vegetable.—— Samples numbered 4015 and 4016 were collected from opposite sides of the lake. Sample No. 3540 was collected from the inlet to the lake.

Water Supply of Plymouth.

Description of Works. — Population in 1885, 7,239. The works are owned by the town. Water was introduced in 1855. The average daily consumption in 1887 was 588,500 gallons. The sources of supply are Great South, Little South and Boot ponds, located south of the village. The ponds are in a line running north and south; Little South Pond is nearest the village, and is distant from it about 2½ miles; Boot Pond is farthest from the village, and is distant from it about 4½ miles. Water from Boot Pond flows into Great South Pond, and thence into Little South Pond; the latter ponds are kept at the same level by a culvert 4 feet wide and 2 feet high which connects them. Lout Pond, located about half way between Little South Pond and the village of Plymouth, is drawn from in emergencies. All the ponds are natural, and have sandy bottoms. Great South Pond is the deepest. The areas of the ponds are as follows: Great South Pond, 275 acres; Little South Pond, 125 acres; Lout Pond, 60 acres; Boot Pond, 40 acres. The watersheds of the ponds are hilly and well wooded, and the soil is sandy.

Water is drawn from Little South Pond into a well located near the shore of the pond, and thence is conveyed to a pumping station near Lout Pond through cement-lined wrought iron pipes. One pipe is 10 inches and the other 16 inches in diameter. The main portion of the town is supplied by gravity, from the larger pipe, in connection with the old distributing reservoir located west of the

village. The area of the reservoir is one-half an acre, its capacity is 1,600,000 gallons, and its depth at high water is 18 feet. The bottom is of clay, and the slopes are paved.

Pumps are used in connection with the new distributing reservoir to supply the high-service district. The new reservoir is circular in shape, and has an area of one-half an acre. Its depth at high water is 15 feet, and its capacity is 1,370,000 gallons. The bottom is covered with a layer of concrete five inches in thickness. The lower portion of the slope is covered with concrete, and the upper portion is paved. The reservoir is located about 600 feet from the pumping station on a branch from the main which leads to the town, and receives the surplus water while pumping. At the pumping station a branch from the larger main from South Pond runs to Lout Pond, and water may be diverted into Lout Pond when desired. The distributing mains and nearly all the service pipes are of wrought iron lined with cement.

Chemical Examination of Water from Great South Pond, Plymouth.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1887.												
222	June 29	June 30	Very slight.	None.	0.0	2.50	0.40	2.10	.0009	.0117	.58	.0000	–
436	July 28	July 29	Very slight.	Very slight.	0.0	2.67	0.12	2.55	.0000	.0080	.67	.0000	–
845	Sept. 22	Sept. 23	Very slight.	Slight.	0.0	2.90	0.60	2.30	.0005	.0151	.62	.0000	–
1055	Oct. 26	Oct. 27	Very slight.	Slight.	0.0	3.00	0.95	2.05	.0010	.0178	.65	.0020	–
1278	Nov. 29	Nov. 30	Distinct.	Slight.	0.0	2.50	0.65	1.85	.0000	.0130	.63	.0020	–
	1888.												
1914	Feb. 28	Feb. 29	Very slight.	Very slight.	0.0	1.85	0.30	1.55	.0008	.0074	.46	.0010	.0000
2313	Apr. 26	Apr. 27	Very slight.	None.	0.0	2.80	0.60	2.20	.0000	.0120	.59	.0050	.0000
2526	May 28	May 29	Very slight.	None.	0.0	2.55	0.65	1.90	.0000	.0088	.58	.0020	.0000
Av.	....	....	....	....	0.0	2.60	0.53	2.07	.0004	.0117	.60	.0015	.0000

Hardness in May, 1888, 0.5. Odor, none or faintly vegetable.——The samples were collected from the pond at the outlet near the surface.

Microscopical Examination.

April, 1888. 1. Blue-green algæ, pr.; 2. Other algæ, pr.; 3. Fungi, 0.0; 4. Animal forms, pr.

May, 1888. 1. Blue-green algæ, 0.0; 2. Other algæ, pr.; 3. Fungi, 0.0; 4. Animal forms, 0.0.

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Diatomaceæ. 4. Protozoa; Entomostraca.

Chemical Examination of Water from Little South Pond, Plymouth.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
221	June 29	June 30	Slight.	None.	0.00	2.68	0.52	2.16	.0006	.0141	.60	.0000	–
435	July 28	July 29	Very slight.	Very slight.	0.10	2.87	0.60	2.27	.0007	.0111	.68	.0000	–
846	Sept. 22	Sept. 23	Slight.	Very slight, white.	0.00	2.95	0.50	2.45	.0006	.0179	.66	.0000	–
1057	Oct. 26	Oct. 27	Very slight.	Sli't, white.	0.00	2.75	0.55	2.20	.0000	.0143	.60	.0020	–
1279	Nov. 29	Nov. 30	Distinct.	Sli't, white.	0.00	2.75	0.80	1.95	.0000	.0172	.65	.0000	–
	1888.												
1915	Feb. 28	Feb. 29	Slight.	None.	0.00	2.35	0.70	1.65	.0002	.0130	.61	.0060	.0000
2314	Apr. 26	Apr. 27	Slight.	None.	0.00	2.50	0.35	2.15	.0004	.0144	.59	.0000	.0000
2525	May 28	May 29	Slight.	Very slight, white.	0.00	2.30	0.55	1.75	.0000	.0132	.56	.0010	.0001
Av.	....	....	....	....	0.00	2.64	0.57	2.07	.0003	.0144	.62	.0011	–

Hardness in May, 1888, 0.2. Odor, faintly vegetable.—— The samples were collected from the pond at the outlet near the surface.

Microscopical Examination.

April, May, 1888. 1. Blue-green algæ, 0.0; 2. Other algæ, pr.; 3. Fungi, 0.0; 4. Animal forms, 0.0. Groups and principal genera of organisms observed: 2. Zoosporeæ; Diatomaceæ.

Chemical Examination of Water from Lout Pond, Plymouth.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
220	June 29	June 30	Slight.	None.	0.30	2.67	0.80	1.87	.0002	.0113	.63	.0060	–
437	July 28	July 29	Very slight.	Very slight.	0.40	3.02	0.45	2.57	.0000	.0118	.65	.0000	–
847	Sept. 22	Sept. 23	Very slight.	Very slight, white.	0.30	3.00	0.75	2.25	.0002	.0201	.65	.0020	–
1056	Oct. 26	Oct. 27	Slight.	Slight.	0.20	2.75	0.70	2.05	.0004	.0168	.65	.0000	–
1280	Nov. 29	Nov. 30	Distinct.	Slight.	0.20	2.55	0.60	1.95	.0004	.0196	.69	.0070	–
	1888.												
2312	Apr. 26	Apr. 27	Slight.	Very slight, white.	0.30	2.85	0.75	2.10	.0000	.0157	.65	.0020	.0001
2527	May 28	May 29	Slight.	Sli't, earthy.	0.20	2.60	0.70	1.90	.0002	.0140	.63	.0030	.0000
Av.	....	....	....	....	0.27	2.78	0.68	2.10	.0002	.0156	.65	.0029	–

Hardness in May, 1888, 0.6. Odor, faintly vegetable.—— The samples were collected from the pond near the ice houses, from 3 to 5 feet beneath the surface.

Microscopical Examination.

April, 1888. 1. Blue-green algæ, 0.0; 2. Other algæ, pr.; 3. Fungi, 0.0; 4. Animal forms, pr.
May, 1888. 1. Blue-green algæ, 0.0; 2. Other algæ, pr.; 3. Fungi, 0.0; 4. Animal forms, 0.0.
Groups and principal genera of organisms observed: 2. Diatomaceæ. 4. Protozoa.

PROVINCETOWN.

The analyses given below were made at a time when investigations were in progress with reference to a public water supply for Provincetown.

Chemical Examination of Water from Clapp's and Shank Painter Ponds, Provincetown.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1889.	1889.											
4073	Feb. 20	Feb. 21	Distinct.	Slight.	1.5	8.15	2.95	5.20	.0042	.0382 .0336	2.39	.0030	.0003
4074	Feb. 20	Feb. 21	Slight.	Consid'ble.	0.6	8.35	2.75	5.60	.0014	.0414 .0314	2.42	.0020	.0003

Hardness of No. 4073, 8.4; of No. 4074, 2.7. Odor of No. 4073, faintly vegetable; of No. 4074, distinctly vegetable. Sample No. 4073 was collected from Clapp's Pond. Sample No. 4074 was collected from Shank Painter Pond.

Microscopical Examination.

No. 4073. 1. Blue-green algæ, 0.0; 2. Other algæ, 0.0; 3. Fungi, 0.0; 4. Animal forms, pr.
No. 4074. 1. Blue-green algæ, 0.0; 2. Other algæ, pr.; 3. Fungi, 0.0; 4. Animal forms, pr.
Groups and principal genera of organisms observed: 2. Diatomaceæ. 4. Protozoa.

Chemical Examination of Water from Tubular Wells at Provincetown.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1889.	1889.											
4075	Feb. 20	Feb. 21	None.	Slight.	0.20	4.75	–	–	.0002	.0094 .0072	1.22	.0030	.0002
4309	Mar. 15	Mar. 16	Sli't, milky.	Slight.	0.20	5.50	–	–	.0000	.0052 .0050	1.58	.0040	.0002
4310	Mar. 15	Mar. 16	Sli't, milky.	Consid'ble.	0.20	6.10	–	–	.0106	.0090 .0074	1.74	.0050	.0002
4311	Mar. 15	Mar. 16	Very slight.	Very slight.	0.05	20.45	–	–	.0000	.0146 .0134	4.11	–	.0010
4405	Mar. 26	Mar. 27	Slight.	Consid'ble.	2.80	9.65	–	–	.0614	.0244 .0198	2.60	.0090	.0001
4406	Mar. 26	Mar. 27	None.	None.	3.30	8.45	–	–	.0246	.0230 .0216	1.69	.0090	.0001

Hardness of 4075, 1.7; of 4309, 1.8; of 4310, 1.6; of 4311, 4.2. Some of these waters when received at the laboratory had a distinct odor of sulphuretted or carburetted hydrogen. When first drawn from the ground the odor was very strong.—— Samples 4075 and 4405 were collected from a tubular well near High Pole Hill. No. 4075 was drawn from 22 feet below the level of the ground and 6 feet below the water table. No. 4405 was drawn from 44 feet beneath the surface of the ground and 28 feet below the water table. No. 4309 was collected from a tubular well near the southerly shore of Clapp's Pond. Water was drawn from about 14 feet beneath the surface of the ground. No. 4310 was also from a tubular well near the southerly shore of Clapp's Pond. Water was drawn from a depth of 22 feet below the surface. No. 4311 was collected from a private tubular well in the west part of the village. No. 4406 was collected from a well 17 feet deep, 16 feet below the water table, near Mrs. Cook's cranberry bog.

Microscopical Examination.

No organisms were found in any of these samples.

Water Supply of Quincy. — Quincy Water Company.

Description of Works. —Population in 1885, 12,145. The works are owned by the Quincy Water Company. Water was introduced in 1884. The average daily consumption in 1888 was about 452,000 gallons. The sources of supply are two large wells in the valley of Town Brook near the Old Colony Railroad, about 2,000 feet south of Quincy Adams Station, and a storage reservoir on Town Brook about $1\frac{1}{4}$ miles above the wells. Previous to the construction of the storage reservoir, water was drawn through a coarse gravel filter from Town Brook opposite the wells, when the supply from the wells was insufficient.

The wells are two in number. One is 30 feet in diameter and 22 feet deep; the second is 32 feet in diameter and 27 feet deep. Each is built of brick and covered. The filter near the wells consisted of 16 pipes laid in four tiers in a trench and embedded in coarse gravel. The quantity of water entering the wells by natural filtration is too small to furnish a sufficient supply for the city, and during the period covered by the analyses given below it was frequently necessary to admit the imperfectly filtered* brook water into the wells. For this reason the analyses of water taken from the wells vary greatly from time to time.

The storage reservoir was constructed in 1888. Its area is 46 acres and its capacity is 180,000,000 gallons; the average depth is 12 feet and the maximum depth about 30 feet. The watershed above the dam has an area of 991 acres and contains considerable meadow and swamp land, but the outer portions are steep and rocky. There are very few inhabitants on this watershed. The watershed of Town Brook between the reservoir and the wells contains a large population, and the population is rapidly increasing in the vicinity of the wells.

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* The term "imperfectly filtered" should not be understood to mean that the water was not thoroughly strained, but rather that it had not undergone all of the changes in chemical composition which may be produced by very slow filtration through sand or gravel under favorable circumstances.

Pumps force the water from the wells or storage reservoir to an open iron tank 35 feet in diameter and 60 feet in height. Water from the storage reservoir is conveyed to the pumping station through a cast-iron pipe. The main pipes are of wrought iron, coated first with a metallic composition known as "kalamein," and then with tar. Wrought iron, some of it galvanized, was formerly used for service pipes, but lead is now used.

Chemical Examination of Water from the Wells of the Quincy Water Company.
[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
238	June 30	July 1	Decided.	Slight.	0.70	7.75	–	–	.0016	.0159	0.70	.0260	–
433	July 28	July 29	Decided.	Sli't, brown.	0.50	8.62	–	–	.0016	.0006	0.94	.0910	–
648	Aug. 30	Aug. 31	Decided.	Sli't, brown.	0.40	8.60	–	–	.0034	.0022	1.05	.0300	–
853	Sept. 23	Sept. 24	Slight.	None.	0.00	10.25	–	–	.0002	.0038	1.34	.0650	–
1065	Oct. 27	Oct. 28	Decided.	Very slight.	0.45	7.75	–	–	.0017	.0090	0.90	.0350	–
1302	Dec. 1	Dec. 3	Very slight.	None.	0.10	9.60	–	–	.0012	.0061	1.19	.1300	–
1501	Dec. 28	Dec. 29	None.	Very slight.	0.00	9.30	–	–	.0000	.0044	1.29	.1300	–
	1888.												
1697	Jan. 25	Jan. 27	Slight.	Very slight.	0.40	5.25	–	–	.0022	.0116	0.50	.0280	.0001
1908	Feb. 28	Feb. 29	Distinct.	Very slight.	0.50	4.40	–	–	.0007	.0171	0.49	.0200	.0003
2102	Mar. 27	Mar. 27	None.	None.	0.05	8.20	–	–	.0000	.0036	1.14	.1000	.0000
2308	Apr. 26	Apr. 26	None.	None.	0.10	8.35	–	–	.0004	.0054	1.14	.0450	.0001
2522	May 28	May 29	None.	Very slight, earthy.	0.00	9.80	–	–	.0000	.0006	1.40	.0850	.0000
3392	Oct. 18	Oct. 19	Slight.	Very slight.	0.15	9.15	–	–	.0000	.0064 .0046	1.24	.1200	.0001

Hardness in May, 1888, 5.0.——The samples were collected from a faucet at the pumping station. Most of these samples are mixtures of the well water proper with imperfectly filtered brook water.

Microscopical Examination.

	1888. Mar.	1888. Apr.	1888. May.	1888. Oct.
1. Blue-green Algæ, ...	0.0	0.0	pr.	0.0
2. Other Algæ, ...	0.0	pr.	pr.	pr.
3. Fungi, ...	0.0	0.0	0.0	0.4
4. Animal Forms, ...	0.0	pr.	pr.	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Diatomaceæ. 3. Schizomycetes. 4. Protozoa.

Chemical Examination of Water from Town Brook above the Storage Reservoir of the Quincy Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
1064	Oct. 27	Oct. 28	Slight.	Sli't, brown.	0.50	5.30	1.50	3.80	.0000	.0133	.65	.0080	–
	1888.												
3495	Nov. 5	Nov. 6	Slight.	Sli't, brown.	0.90	4.25	1.40	2.85	.0002	.0164	.49	.0080	.0004
3613	Nov. 27	Nov. 28	Slight.	Con., earthy and floc't.	0.10	3.60	1.00	2.60	.0000	.0104 .0070	.84	.0080	.0002
3750	Dec. 19	Dec. 20	Very slight.	Sli't, earthy and floc't.	0.40	3.35	0.90	2.45	.0000	.0110 .0090	.41	.0060	.0003
	1889.												
3909	Jan. 23	Jan. 24	None.	Very slight.	0.20	3.40	0.70	2.70	.0000	.0080 .0066	.55	.0120	.0001
4182	Feb. 28	Mar. 1	Very slight.	Very slight.	0.10	4.20	0.90	3.30	.0000	.0084 .0062	.51	.0120	.0001
4424	Mar. 28	Mar. 29	Slight.	Consid'ble.	0.50	3.40	1.15	2.25	.0012	.0176 .0146	.51	.0060	.0002
4572	Apr. 25	Apr. 26	Very slight.	Consid'ble.	1.10	3.80	1.65	2.15	.0000	.0260 .0214	.47	.0030	.0002
4713	May 22	May 23	Very slight.	Consid'ble.	3.50	7.10	4.25	2.85	.0026	.0472 .0380	.42	.0050	.0000
Av.	....	....	....	....	0.81	4.14	1.49	2.65	.0004	.0176	.54	.0076	.0002

Odor, faintly vegetable or grassy.—— The samples were collected from the brook above the new storage reservoir, excepting No. 1064, which was collected near the location of the dam when work was begun. Nos. 3613 and 4713 were collected just after a very heavy storm.

Microscopical Examination.

	1888. Nov.	1888. Nov.	1888. Dec.	1889. Jan.	1889. Feb.	1889. Mar.	1889. Apr.	1889. May.
1. Blue-green Algæ,	0.0	0.0	0.0	0.0	0.0	0.0	pr.	0.0
2. Other Algæ,	pr.	0.1	0.2	0.2	2.0	10.0	1.2	0.6
3. Fungi,	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms,	1.2	0.1	pr.	0.0	0.0	0.3	0.0	0.1

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ, Desmidiaceæ; Diatomaceæ, *Synedra*, *Tabellaria;* Zygnemaceæ. 4. Protozoa, *Hydromorum;* Spongiaria.

Chemical Examination of Water from the Storage Reservoir of the Quincy Water Company.

[Parts per 100,000.]

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.	Chlorine.	Nitrates.	Nitrites.
	1888.												
3612	Nov. 27	Nov. 28	Slight.	Con., earthy and floc't.	0.60	4.20	1.05	3.15	.0044	.0202 .0150	.72	.0150	.0003
3751	Dec. 19	Dec. 20	Distinct.	Con., light.	0.40	3.70	1.20	2.50	.0016	.0154 .0114	.63	.0150	.0003
	1889.												
3910	Jan. 23	Jan. 24	Slight.	Sli't, green.	0.15	3.30	0.75	2.55	.0000	.0132 .0102	.49	.0100	.0003
4183	Feb. 28	Mar. 1	Distinct.	Sli't, green.	0.30	3.80	0.95	2.85	.0012	.0320 .0144	.60	.0180	.0002
4425	Mar. 28	Mar. 29	Distinct.	Slight.	0.30	3.45	1.15	2.30	.0000	.0228 .0146	.50	.0040	.0003
4573	Apr. 25	Apr. 26	Distinct.	Consid'ble.	0.45	3.50	1.05	2.45	.0036	.0228 .0188	.54	.0030	.0003
4714	May 22	May 23	Very slight.	Slight.	0.70	3.80	1.25	2.55	.0078	.0244 .0204	.55	.0020	.0002
Av.	....	....	....	....	0.41	3.68	1.06	2.62	.0027	.0215 .0150	.58	.0096	.0003

Odor, faintly vegetable.—— The samples were collected from the reservoir at the dam. There were 5.25 inches of rainfall in the 36 hours previous to the time of collecting sample No. 3612. There were 3.37 inches in the two days previous to the day of collecting 3751. The reservoir began to fill Oct. 12, 1888, and was full for the first time on Dec. 19, 1888.

Microscopical Examination.

	1888.		1889.				
	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ, ...	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	pr.	0.0	pr.	0.1	0.6	2.1	0.1
3. Fungi, ...	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, ...	pr.	0.0	0.9	0.8	0.4	0.1	3.2

Groups and principal genera of organisms observed: 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Synedra*. 4. Protozoa, *Dinobryon*.

Water Supply of Randolph and Holbrook.

Description of Works. — Population in 1885, Randolph, 3,807; Holbrook, 2,334; total, 6,151. The main works are owned jointly by the towns of Randolph and Holbrook, but each town owns and controls its distributing system. Water was introduced in 1888. The average daily consumption for the ten months from Oct. 1,

1888, to Aug. 1, 1889, was 118,713 gallons. The source of supply is Great Pond in Randolph and Braintree. The surface of the pond has been raised $1\frac{1}{2}$ feet above its natural level by a dam built many years ago at the outlet. Its area is 130 acres and its maximum depth 22 feet. The larger part of the pond is free from shallow places, and its general depth is about 11 feet. There is, however, a large area of meadow land at the southern end which is overflowed when the pond is full. The bottom of the pond is sandy and gravelly around the shores and muddy in the deeper portions. Its drainage area of 3.44 square miles contains a portion of the village of Randolph and a large amount of swamp and meadow land. Pumps force the water from the pond to two open iron tanks, one in each town. The Randolph tank is 30 feet in diameter and 125 feet in height. The Holbrook tank is 30 feet in diameter and 112 feet in height. Distributing mains are of cast iron. Service pipes are of wrought iron lined with cement.

Chemical Examination of Water from Great Pond, Randolph.

[Parts per 100,000.]

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.
	1887.												
849	Sept. 23	Sept. 24	Slight.	Sli't, brown.	0.40	4.35	1.25	3.10	.0002	.0293	.53	.0030	–
	1888.												
1977	Mar. 8	Mar. 8	Distinct.	None.	0.55	3.75	1.05	2.70	.0006	.0228	.40	.0050	.0001
2149	Apr. 3	Apr. 3	Distinct.	Very slight.	1.20	3.95	1.00	2.95	.0005	.0204	.46	.0080	.0003
2295	Apr. 24	Apr. 24	Slight.	Very slight, white.	1.10	3.70	1.55	2.15	.0002	.0192	.46	.0080	.0002
2515	May 25	May 26	Distinct.	Very slight.	1.00	4.05	1.50	2.55	.0012	.0246	.47	.0030	.0003
2737	July 6	July 7	Slight.	Slight.	0.80	4.30	1.80	2.50	.0002	.0288 .0248	.47	.0030	.0001
2889	Aug. 7	Aug. 8	Slight.	Slight.	0.45	4.70	1.90	2.80	.0022	.0304 .0268	.50	.0040	.0000
3041	Sept. 3	Sept. 5	Very slight.	Sli't, black.	0.40	3.95	1.45	2.50	.0006	.0208 .0200	.39	.0030	.0002
3371	Oct. 15	Oct. 16	Very slight.	Very slight.	0.60	4.20	1.65	2.55	.0004	.0266 .0266	.47	.0040	.0001
3451	Oct. 23	Oct. 26	Very slight.	Very slight.	1.10	4.30	1.90	2.40	.0014	.0298 .0254	.48	.0020	.0000
Av.	....	....	....	....	0.76	3.96	1.27	2.69	.0008	.0253	.46	.0043	.0001

Hardness in May, 1888, 1.3. Odor, vegetable, occasionally peaty.——The samples were collected from a faucet in the pumping station, while pumping, or from the pond over the end of the inlet pipe.

Microscopical Examination.

	1888.				
	July.	Aug.	Sept.	Oct.	Oct.
1. Blue-green Algæ, ...	pr.	pr.	0.0	0.0	0.0
2. Other Algæ, ...	0.6	0.4	0.1	pr.	pr.
3. Fungi, ...	0.0	0.0	0.0	pr.	0.0
4. Animal Forms, ...	0.3	pr.	pr.	pr.	pr.

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Diatomaceæ. 3. Schizomycetes. 4. Protozoa; Spongiaria; Entomostraca.

Chemical Examination of Water from Faucets in Randolph and Holbrook supplied from the Randolph and Holbrook Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.	1888.											
3651	Dec. 5	Dec. 6	Very slight.	Very slight.	0.70	4.30	1.80	2.50	.0004	.0228 .0216	.55	.0080	.0002
3795	Dec. 27	Dec. 28	Very slight.	Very slight.	0.70	4.20	1.65	2.55	.0018	.0206 .0174	.60	.0080	.0002
	1889.	1889.											
3895	Jan. 23	Jan. 23	Decided.	Heavy, red brown.	0.70	3.70	1.25	2.45	.0000	.0172 .0142	.51	.0100	.0001
4112	Feb. 25	Feb. 25	Very slight.	Very slight.	0.60	4.05	1.55	2.50	.0000	.0142 .0112	.52	.0100	.0003
4455	Apr. 1	Apr. 2	Very slight.	Slight.	0.50	3.55	1.10	2.45	.0002	.0130 .0120	.49	.0060	.0002
4587	Apr. 26	Apr. 27	None.	None.	0.40	3.65	0.95	2.70	.0008	.0160 .0138	.52	.0050	.0003
4710	May 21	May 23	Very slight.	Very slight.	0.45	4.55	2.30	2.25	.0020	.0204 .0188	.54	.0030	.0002

Odor, faintly vegetable.——Nos. 3895 and 4455 were collected from faucets in Holbrook. The remaining samples were collected from faucets in Randolph.

Microscopical Examination.

	1888.		1889.				
	Dec.	Dec.	Jan.	Feb.	Apr.	Apr.	May.
1. Blue-green Algæ, ...	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	0.0	pr.	0.2	6.3	1.9	1.3	1.3
3. Fungi, ...	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, ...	0.0	0.0	0.0	0.1	1.4	1.2	0.4

Groups and principal genera of organisms observed: 2. Diatomaceæ, *Stephanodiscus*, *Synedra*; Zygnemaceæ. 4. Protozoa, *Dinobryon*.

Water Supply of Revere and Winthrop. — Revere Water Company.

Description of Works. — Population in 1885, Revere, 3,637; Winthrop, 1,370; total, 5,007. In addition to the permanent population there is a very large summer population at the beaches. The works are owned by the Revere Water Company, and were built in 1884. The average daily consumption in 1888 was 361,489 gallons. The sources of supply are two large wells, in the bottoms of which tubular wells are sunk, and a large number of two-inch tubular wells in three groups located several hundred feet from the main wells. The wells are located in the valley of a small brook about one-fourth of a mile from salt marshes, and about one mile from the seashore at Revere Beach; they are sunk through clay to a gravel stratum which is reached at a depth of from 50 to 70 feet beneath the surface. Well No. 1 is 30 feet in diameter and 20 feet in depth. Three 6-inch and two 2-inch tubular wells have been sunk in the bottom of this well. Well No. 2 is 40 feet in diameter and 20 feet in depth. At the bottom is a smaller well, 8 feet in diameter and 30 feet in depth, and around this smaller well are eight 2-inch tubular wells. The tubular wells, in the three groups, are connected with an auxiliary engine which pumps water from them into the large wells, from which it is pumped by the main engine into the distributing system, the surplus water going to an open distributing reservoir. The area of the superficial watershed of the brook, at a point near the wells, is 430 acres, and it contains a population of about 600. The amount of water pumped in 1888 is equivalent to a depth of 11.3 inches on the superficial watershed. The rainfall in this vicinity in 1888 was about 60 inches. The distributing reservoir is 236 feet long, 194 feet wide and 20 feet deep; its capacity is 1,500,000 gallons. The bottom is of clay, and the slopes are paved. Distributing mains and service pipes are of wrought iron lined with cement. The Revere Water Company obtained the right in 1889 to take an additional supply of water from Crystal Brook in Saugus. For an analysis of the water of this brook, see *Saugus*.

Chemical Examination of Water from the Wells of the Revere Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Exam-ination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albu-minoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
33	June 3	June 4	None.	None.	0.0	22.00	-	-	.0005	.0023	3.10	.1950	-
247	July 5	July 6	None.	None.	0.0	25.32	-	-	.0000	.0028	3.59	.1690	-
490	Aug. 5	Aug. 8	None.	None.	0.0	21.20	-	-	.0002	.0009	2.99	.2270	-
680	Sept. 2	Sept. 3	None.	None.	0.0	21.80	-	-	.0000	.0006	3.24	.1950	-
886	Oct. 4	Oct. 6	Very slight.	None.	0.0	22.00	-	-	.0000	.0016	3.64	.1630	-
1176	Nov. 2	Nov. 14	None.	None.	0.0	21.20	-	-	.0000	.0008	3.51	.1000	-
1434	Dec. 15	Dec. 19	Very slight.	None.	0.0	21.70	-	-	.0004	.0024	3.55	.1200	-
	1888.												
1537	Jan. 4	Jan. 5	Very slight.	None.	0.0	21.40	-	-	.0000	.0046	3.48	.1200	.0020
1756	Feb. 3	Feb. 6	Very slight.	None.	0.0	21.50	-	-	.0000	.0016	3.64	.1500	.0020
1963	Mar. 6	Mar. 7	Distinct.	Very slight.	0.0	21.70	-	-	.0000	.0042	3.51	.1600	.0010
2175	Apr. 6	Apr. 10	Sli't, milky.	None.	0.0	22.40	-	-	.0000	.0022	3.56	.1200	.0022
2519	May 24	May 28	Slight.	Very slight.	0.0	21.25	-	-	.0000	.0012	3.53	.1800	.0020
2693	June 28	June 30	None.	None.	0.0	24.65	-	-	.0002	.0018	3.64	.1300	.0029
2760	July 9	July 12	None.	None.	0.0	23.05	-	-	.0000	.0034	3.52	.2000	.0024
2928	Aug. 10	Aug. 14	Slight.	Very slight, white.	0.0	25.10	-	-	.0002	.0028	3.54	.0350	.0024
3258	Sept. 24	Sept. 25	None.	None.	0.0	24.00	-	-	.0000	.0008	3.65	.1200	.0025
3466	Oct. 30	Oct. 30	Very slight.	None.	0.0	22.60	-	-	.0004	.0006	3.37	.1000	.0005
3622	Nov. 30	Dec. 1	None.	None.	0.0	22.40	-	-	.0000	.0018	3.27	.0700	.0031
3742	Dec. 19	Dec. 19	Sli't, milky.	None.	0.0	22.25	-	-	.0000	.0008	3.18	.1600	.0036
	1889.												
3841	Jan. 11	Jan. 11	Distinct.	Sli't, white.	0.0	21.90	-	-	.0000	.0006	3.18	.1500	.0034
4010	Feb. 12	Feb. 12	None.	None.	0.0	21.95	-	-	.0000	.0010	3.26	.1400	.0038
4384	Mar. 23	Mar. 23	Very slight.	None.	0.0	23.35	-	-	.0000	.0020	3.30	.1200	.0020
4569	Apr. 25	Apr. 25	None.	None.	0.0	22.80	-	-	.0000	.0022	3.30	.1300	.0024
4711	May 22	May 23	Sli't, milky.	None.	0.0	23.60	-	-	.0000	.0022	3.37	.1250	.0020
Av.	....	....	....	....	0.0	22.55	-	-	.0001	.0019	3.41	.1408	.0024

Hardness in May, 1888, 12.3. Odor, none.——The samples were collected from a faucet in the pumping station, while pumping, or from one of the large wells.

Microscopical Examination.

	1888.								1889.				
	Apr.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ, . .	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	0.0	0.0	0.0	pr.	0.0	0.0	0.0	pr.	0.0	0.0	0.0	0.0	pr.
3. Fungi, ...	0.0	pr.	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, . . .	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Groups and principal genera of organisms observed: 2. Palmellaceæ; Diatomaceæ. 3. Schizomycetes. 4. Protozoa; Spongiaria.

Chemical Examination of Water from the Distributing Reservoir of the Revere Water Company.

[Parts per 100,000.]

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.
	1887.												
887	Oct. 4	Oct. 6	None.	None.	0.00	22.10	–	–	.0008	.0044	3.60	.1300	–
1177	Nov. 13	Nov. 14	Very slight.	Very slight.	0.00	22.00	–	–	.0000	.0064	3.50	.1100	–
1435	Dec. 15	Dec. 19	Very slight.	Sli't, earthy.	0.00	22.20	–	–	.0020	.0090	3.53	.1500	–
	1888.												
1538	Jan. 4	Jan. 5	Very slight.	Sli't, white.	0.00	21.40	–	–	.0000	.0012	3.49	.1400	.0020
1755	Feb. 3	Feb. 6	Slight.	Very slight, white.	0.00	21.50	–	–	.0000	.0030	3.55	.1500	.0014
1962	Mar. 6	Mar. 7	Distinct.	Slight.	0.00	21.80	–	–	.0026	.0138	3.47	.1000	.0015
2176	Apr. 6	Apr. 10	Distinct.	Slight.	0.10	23.50	–	–	.0048	.0176	3.52	.1200	.0020
2520	May 24	May 28	Distinct.	Sli't, brown.	0.05	22.25	–	–	.0060	.0074	3.59	.1600	.0015
2694	June 28	June 30	Distinct.	Sli't, white.	0.00	23.50	–	–	.0008	.0084 .0034	3.49	.1200	.0017
2761	July 9	July 12	Slight.	Sli't, brown.	0.00	23.25	–	–	.0050	.0090 .0046	3.41	.0900	.0019
2929	Aug. 10	Aug. 14	None.	Very slight, white.	0.00	24.40 23.80	–	–	.0072	.0070 .0060	3.45	.0550	.0015
3259	Sept. 24	Sept. 25	Very slight.	Very slight.	0.00	24.25 23.80	–	–	.0000	.0052 .0026	3.52	.1000	.0013
3467	Oct. 30	Oct. 30	Very slight.	Very slight.	0.00	22.25 21.80	–	–	.0004	.0020 .0012	3.42	.1000	.0020
3623	Nov. 30	Dec. 1	Slight.	Slight.	0.00	20.90	–	–	.0000	.0020	3.10	.0850	.0018
3743	Dec. 19	Dec. 19	Slight.	Very slight.	0.00	21.35	–	–	.0018	.0104	3.31	.0800	.0017

Chemical Examination of Water from the Distributing Reservoir of the Revere Water Company — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
3842	Jan. 11	Jan. 11	Slight.	Sli't, white.	0.05	21.40	–	–	.0000	.0022	3.19	.1300	.0021
4011	Feb. 12	Feb. 12	Very slight.	Very slight.	0.00	22.90 22.45	–	–	.0006	.0028 .0024	3.34	.1360	.0023
4385	Mar. 23	Mar. 23	Slight.	Slight.	0.00	23.90	–	–	.0000	.0042 .0018	3.37	.1100	.0021
4570	Apr. 25	Apr. 25	Very slight.	Very slight.	0.00	22.80	–	–	.0000	.0072 .0024	3.36	.1150	.0021
4712	May 22	May 23	Distinct, milky.	Con., floc't.	0.00	23.00	–	–	.0014	.0144 .0084	3.30	.0300	.0022
Av.	....	....	....	....	–	22.44	–	–	.0017	.0069	3.43	.1106	.0018

Hardness in May, 1888, 12.3. Odor, frequently vegetable and disagreeable, occasionally none. — The samples were collected from the reservoir at the surface.

Microscopical Examination.

	1888. June.	1888. July.	1888. Aug.	1888. Sept.	1888. Oct.	1888. Nov.	1888. Dec.	1889. Jan.	1889. Feb.	1889. Mar.	1889. Apr.	1889. May.
1. Blue-green Algæ, ...	0.0	12.0	–	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	32.0	100.1	–	0.8	0.8	pr.	3.0	64.6	0.4	42.0	65.1	7.0
3. Fungi, ...	0.0	0.0	–	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, ...	64.0	37.1	–	1.2	1.0	0.0	0.0	64.7	8.7	50.3	100.1	4.5

Groups and principal genera of organisms observed: 1. Cyanophyceæ, *Merismopedia*. 2. Palmellaceæ; Zoosporeæ; Diatomaceæ, *Asterionella*, *Synedra*, *Tabellaria*. 4. Protozoa, *Peridinium*, *Trachelomonas;* Spongiaria; Rotifera; Entomostraca.

Chemical Examination of Water from a Faucet in Winthrop supplied from the Works of the Revere Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
682	Sept. 5	Sept. 6	None.	None.	0.0	24.05	–	–	.0000	.0022	3.37	.1950	–

Water Supply of Richmond Iron Works, Richmond.

This is a small supply introduced by a manufacturing company for the purpose of furnishing water to its employees. The source of supply is a small reservoir on Center Brook. The reservoir has an area of half an acre and a depth of 10 feet. The bottom is of gravel. Water is distributed by gravity. Distributing mains are of cast iron. Service pipes are of galvanized iron.

Chemical Examination of Water from a Faucet in the Village of Richmond.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1887.												
46	June 6	June 8	None.	Very slight.	0.0	17.60	1.65	15.95	.0010	.0101	.17	.0260	-

Hardness, 12.0. Odor, none.

Water Supply of Rockland.

This town is supplied jointly with Abington. *See Abington.*

Water Supply of Salem.

Description of Works.—Population in 1885, 28,090. The works are owned by the city. Water was introduced Dec. 25, 1868. Previous to that date the city was supplied by the Salem and Danvers Aqueduct Company, water being introduced by this corporation in 1799. The average daily consumption in 1888 was 2,106,000 gallons. The source of supply is Wenham Lake in Beverly and Wenham. The area of the lake is 320 acres, and its maximum depth is 47 feet. The bottom is of gravel and sand. The natural surface of the lake has been raised two feet by a dam at the outlet. The watershed of 1,716 acres consists of low, gravelly and sandy hills, slightly wooded, but generally devoted to pasturage or cultivation. It contains a considerable population, but there are very few inhabitants in the vicinity of the lake. Pumps force the water from the lake to a distributing reservoir situated about one mile south of the lake, between it and the city of Salem. By an arrangement of self-acting valves nearly all the water passes around the reservoir directly to the city; but, when

Chemical Examination of Water from the Distributing Reservoir of the Revere Water Company — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
3842	Jan. 11	Jan. 11	Slight.	Sli't, white.	0.05	21.40	–	–	.0000	.0022	3.19	.1300	.0021
4011	Feb. 12	Feb. 12	Very slight.	Very slight.	0.00	22.90 22.45	–	–	.0006	.0028 .0024	3.34	.1360	.0023
4385	Mar. 23	Mar. 23	Slight.	Slight.	0.00	23.90	–	–	.0000	.0042 .0018	3.37	.1100	.0021
4570	Apr. 25	Apr. 25	Very slight.	Very slight.	0.00	22.80	–	–	.0000	.0072 .0024	3.36	.1150	.0021
4712	May 22	May 23	Distinct, milky.	Con., floc't.	0.00	23.00	–	–	.0014	.0144 .0084	3.30	.0300	.0022
Av.	....	....	....	....	–	22.44	–	–	.0017	.0069	3.43	.1106	.0018

Hardness in May, 1888, 12.3. Odor, frequently vegetable and disagreeable, occasionally none.—— The samples were collected from the reservoir at the surface.

Microscopical Examination.

	1888. June.	1888. July.	1888. Aug.	1888. Sept.	1888. Oct.	1888. Nov.	1888. Dec.	1889. Jan.	1889. Feb.	1889. Mar.	1889. Apr.	1889. May.
1. Blue-green Algæ, ...	0.0	12.0	–	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	32.0	100.1	–	0.8	0.8	pr.	3.0	64.6	0.4	42.0	65.1	7.0
3. Fungi, ...	0.0	0.0	–	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, ...	64.0	37.1	–	1.2	1.0	0.0	0.0	64.7	8.7	50.3	100.1	4.5

Groups and principal genera of organisms observed: 1. Cyanophyceæ, *Merismopedia*. 2. Palmellaceæ; Zoosporeæ; Diatomaceæ, *Asterionella*, *Synedra*, *Tabellaria*. 4. Protozoa, *Peridinium*, *Trachelomonas*; Spongiaria; Rotifera; Entomostraca.

Chemical Examination of Water from a Faucet in Winthrop supplied from the Works of the Revere Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
682	Sept. 5	Sept. 6	None.	None.	0.0	24.05	–	–	.0000	.0022	3.37	.1950	–

Water Supply of Richmond Iron Works, Richmond.

This is a small supply introduced by a manufacturing company for the purpose of furnishing water to its employees. The source of supply is a small reservoir on Center Brook. The reservoir has an area of half an acre and a depth of 10 feet. The bottom is of gravel. Water is distributed by gravity. Distributing mains are of cast iron. Service pipes are of galvanized iron.

Chemical Examination of Water from a Faucet in the Village of Richmond.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
46	June 6	June 8	None.	Very slight.	0.0	17.60	1.65	15.95	.0010	.0101	.17	.0260	–

Hardness, 12.0. Odor, none.

Water Supply of Rockland.

This town is supplied jointly with Abington. *See Abington.*

Water Supply of Salem.

Description of Works. —Population in 1885, 28,090. The works are owned by the city. Water was introduced Dec. 25, 1868. Previous to that date the city was supplied by the Salem and Danvers Aqueduct Company, water being introduced by this corporation in 1799. The average daily consumption in 1888 was 2,106,000 gallons. The source of supply is Wenham Lake in Beverly and Wenham. The area of the lake is 320 acres, and its maximum depth is 47 feet. The bottom is of gravel and sand. The natural surface of the lake has been raised two feet by a dam at the outlet. The watershed of 1,716 acres consists of low, gravelly and sandy hills, slightly wooded, but generally devoted to pasturage or cultivation. It contains a considerable population, but there are very few inhabitants in the vicinity of the lake. Pumps force the water from the lake to a distributing reservoir situated about one mile south of the lake, between it and the city of Salem. By an arrangement of self-acting valves nearly all the water passes around the reservoir directly to the city; but, when

the amount of water pumped is in excess of the consumption, the surplus goes to the reservoir. The reservoir is 400 feet square at the top and 20 feet deep at high water; its capacity is 20,000,000 gallons. The bottom is covered with gravel, and the slopes are paved. The force-main from the pumping station to the reservoir, and the main from the reservoir to the city, are of cast iron. The distributing mains are nearly all of wrought iron lined with cement, a few being of cast iron. Service pipes are of galvanized iron. Water was supplied from the Salem works to the town of Beverly until Oct. 1, 1887, when the latter town completed independent works from Wenham Lake.

Chemical Examination of Water from Wenham Lake, Salem Water Works.

[Parts per 100,000.]

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.
	1887.												
153	June 20	June 21	Slight.	None.	0.05	5.07	1.30	3.77	.0026	.0083	.70	.0000	–
370	July 20	July 21	Very slight.	Very slight.	0.00	4.45	0.65	3.80	.0030	.0128	.69	.0000	–
574	Aug. 17	Aug. 18	None.	None.	0.05	4.47	0.55	3.92	.0039	.0131	.71	.0070	–
778	Sept. 14	Sept. 16	Distinct.	Very slight.	0.00	4.45	0.75	3.70	.0014	.0142	.73	.0000	–
985	Oct. 18	Oct. 20	Slight.	Sli't, brown.	0.10	4.60	0.50	4.10	.0029	.0164	.69	.0000	–
1207	Nov. 16	Nov. 18	Slight.	Slight.	0.05	5.00	0.95	4.05	.0022	.0134	.74	.0020	–
1439	Dec. 19	Dec. 20	Distinct.	Slight.	0.10	5.10	1.05	4.05	.0012	.0166	.77	.0040	–
	1888.												
1618	Jan. 17	Jan. 19	Slight.	Very slight.	0.00	4.90	0.95	3.95	.0000	.0170	.74	.0050	–
1833	Feb. 14	Feb. 15	Very slight.	Very slight.	0.05	4.60	0.80	3.80	.0032	.0134	.77	.0080	.0000
2046	Mar. 19	Mar. 20	Slight.	Very slight	0.10	4.65	0.65	4.00	.0008	.0146	.74	.0080	.0001
2240	Apr. 17	Apr. 18	Distinct.	Very slight.	0.15	4.30	0.65	3.65	.0008	.0170	.70	.0050	.0002
2432	May 15	May 16	Slight.	Very slight.	0.00	3.85	0.60	3.25	.0012	.0150	.69	.0030	.0001
2662	June 25	June 26	Distinct.	Sli't, green.	0.10	4.50	0.90	3.60	.0018	.0132	.70	.0020	.0000
2779	July 16	July 17	Very slight.	Very slight.	0.05	4.30	1.15	3.15	.0002	.0160 .0118	.69	.0020	.0001
2933	Aug. 14	Aug. 15	Slight.	Slight.	0.00	5.80	1.60	4.20	.0014	.0140 .0130	.74	.0030	.0000
3219	Sept. 18	Sept. 19	Slight.	Very slight.	0.05	4.65	1.00	3.65	.0008	.0140 .0120	.68	.0050	.0002
3380	Oct. 16	Oct. 17	Slight.	Sli't, green.	0.00	4.30	0.65	3.65	.0036	.0142 .0108	.67	.0060	.0002
3577	Nov. 20	Nov. 21	Very slight.	Slight.	0.10	4.35	1.05	3.30	.0006	.0166 .0154	.71	.0070	.0001
3706	Dec. 12	Dec. 14	Slight.	Sli't, brown.	0.00	5.80	1.65	4.15	.0090	.0096 .0070	.93	.0160	.0001

Chemical Examination of Water from Wenham Lake, Salem Water Works — Con.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
3863	Jan. 16	Jan. 18	Distinct.	Very slight.	0.05	4.10	0.65	3.45	.0004	.0148 .0112	.70	.0080	.0003
4047	Feb. 19	Feb. 21	Very slight.	Very slight.	0.10	4.20	1.25	2.95	.0002	.0140 .0106	.73	.0070	.0002
4350	Mar. 19	Mar. 20	Very slight.	Slight.	0.05	4.30	1.15	3.15	.0002	.0140 .0110	.71	.0060	.0001
4524	Apr. 16	Apr. 17	Slight.	Slight.	0.00	4.25	1.00	3.25	.0010	.0174 .0132	.71	.0060	.0001
4667	May 14	May 14	Very slight.	Slight.	0.10	4.30	1.20	3.10	.0008	.0142 .0112	.73	.0020	.0001
Av.	....	....	....	....	0.05	4.62	0.80	3.82	.0018	.0143	.72	.0047	.0001

Hardness in May, 1888, 1.9. Odor, faintly vegetable, occasionally mouldy, rarely disagreeable. —— The samples were collected from a faucet at the pumping station, while pumping, until June, 1888. The remaining samples, including the one collected in June, 1888, were collected from the lake, one foot beneath the surface and about 40 feet from shore, excepting 2863 and 4047, which were collected from a faucet at the pumping station.

Microscopical Examination.

	1888. June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	1889. Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ, ...	0.8	pr.	pr.	0.1	0.0	pr.	0.2	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	0.1	1.9	3.8	1.4	18.2	21.7	6.8	35.4	20.6	3.9	5.1	0.5
3. Fungi, ...	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, ...	pr.	2.7	0.7	0.5	0.9	0.1	pr.	0.2	0.4	0.2	0.1	0.6

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Diatomaceæ, *Asterionella*, *Melosira*, *Stephanodiscus*, *Synedra*. 3. Schizomycetes. 4. Protozoa, *Dinobryon*; Spongiaria; Rotifera; Entomostraca.

Table showing Heights of Water in Wenham Lake at Times when Samples of Water were collected for Analysis.

NOTE: High-water mark is 30.17 feet.

DATE.	Height of Water.	DATE.	Height of Water.
1887.		**1888.**	
June 20, ...	30.00	June 25, ...	29.83
July 20, ...	29.17	July 16, ...	29.18
August 17, ...	28.64	August 14, ...	28.63
September 14, ...	28.58	September 18, ...	28.00
October 18, ...	27.85	October 16, ...	28.66
November 16, ...	27.50	November 20, ...	29.10
December 19, ...	27.27	December 12, ...	30.25
1888.		**1889.**	
January 17, ...	27.69	January 16, ...	30.33
February 14, ...	27.42	February 19, ...	30.25
March 19, ...	28.50	March 19, ...	30.15
April 17, ...	30.42	April 16, ...	31.08
May 15, ...	30.69	May 14, ...	29.90

Chemical Examination of Water from the Distributing Reservoir of the Salem Water Works.

[Parts per 100,000]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
152	June 20	June 21	Slight.	Very slight.	0.05	4.77	1.17	3.60	.0017	.0134	.69	.0000	-
371	July 20	July 21	Slight.	Very slight.	0.00	4.75	0.77	3.98	.0022	.0207	.72	.0000	-
573	Aug. 17	Aug. 18	Very slight.	Sli't, brown.	0.05	4.85	1.20	3.65	.0004	.0178	.69	.0070	-
777	Sept. 14	Sept. 16	Decided.	Sli't, earthy.	0.00	4.80	0.90	3.90	.0014	.0180	.77	.0000	-
984	Oct. 18	Oct. 20	Very slight.	Sli't, white.	0.00	4.75	0.60	4.15	.0028	.0246	.76	.0000	-
1208	Nov. 17	Nov. 18	Very slight.	Slight.	0.00	4.80	0.70	4.10	.0024	.0177	.75	.0000	-
1438	Dec. 19	Dec. 20	Very slight.	Very slight.	0.05	4.75	0.70	4.05	.0008	.0153	.77	.0020	-
	1888.												
1617	Jan. 17	Jan. 19	Distinct.	Sli't, brown.	0.00	5.40	1.30	4.10	.0006	.0205	.80	.0050	-
1834	Feb. 14	Feb. 15	Distinct.	Sli't, white.	0.05	4.90	1.00	3.90	.0032	.0123	.75	.0090	.0000
2045	Mar. 19	Mar. 20	Distinct.	Slight.	0.10	4.60	0.85	3.75	.0012	.0178	.72	.0080	.0001
2239	Apr. 17	Apr. 18	Decided.	Sli't, white.	0.10	4.50	0.70	3.80	.0010	.0232	.73	.0080	.0003
2433	May 15	May 16	Distinct.	Very slight.	0.05	4.50	0.70	3.80	.0004	.0202	.69	.0030	.0000
Av.	....	....	....	....	0.04	4.78	0.88	3.90	.0015	.0185	.74	.0035	.0001

Hardness in May, 1888, 1.7. Odor, faintly vegetable, occasionally mouldy, rarely disagreeable.—— The samples were collected from the south-east corner of the reservoir.

Microscopical Examination.

	1888. March.	1888. April.	1888. May.
1. Blue-green Algæ, ...	0.0	0.0	0.0
2. Other Algæ, ...	pr.	pr.	pr.
3. Fungi, ...	0.0	0.0	0.0
4. Animal Forms, ...	pr.	pr.	pr.

Groups and principal genera of organisms observed: 2. Palmellaceæ; Zoosporeæ; Diatomaceæ. 4. Protozoa; Rotifera; Entomostraca.

Water Supply of Saugus.

Population in 1885, 2,855. The distributing system is owned by the town. Water is supplied by the city of Lynn, and was introduced in 1878. *See Lynn.*

The following analyses were made during investigations for an additional water supply for the Revere Water Company.

Chemical Examination of Water from Crystal Brook in Saugus.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1889.												
4072	Feb. 20	Feb. 21	Sli't, milky.	Consid'ble.	0.4	4.15	1.40	2.75	.0008	.0186 .0134	.46	.0060	.0003

Hardness, 1.4. Odor, none.——The sample was collected from Crystal Brook, where it crosses Forest Street, just below the proposed dam of the Revere Water Company.

Microscopical Examination.

1. Blue-green algæ, 0.0; 2. Other algæ, 1.9; 3. Fungi, 0.0; 4. Animal forms, 0.2.

Groups and principal genera of organisms observed: 2. Diatomaceæ; Desmidiaceæ. 4. Protozoa.

Chemical Examination of Water from a Tubular Well in Saugus.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1888.												
3796	Dec. 27	Dec. 28	None.	None.	0.0	10.75	–	–	.0002	.0020	.85	.0030	.0002

Odor, none.——The sample was collected from a tubular well 40 feet deep, sunk by the Revere Water Company, on the bank of a small brook about half a mile north of Pleasant Hill Station in Saugus.

Microscopical Examination.

No organisms.

Water Supply of Sharon. — Sharon Water Company.

Description of Works. — Population in 1885, 1,328. The works are owned by the Sharon Water Company, and were built in 1885. The average daily consumption in 1888 was 50,600 gallons. The source of supply is a well 16 feet in diameter and 16 feet deep, near Beaver Brook, a short distance from the Sharon Station on the Providence Division of the Old Colony Railroad. Pumps force the water from the well to an open iron tank 20 feet in diameter and 80 feet in height. The inlet pipe extends 4 feet above the top of the tank. Water is drawn out at the bottom. The tank is situated between the pumping station and the village, and all water pumped to the village passes through it. Distributing mains are of cast iron. Service pipes are nearly all of lead, a few being of iron.

Chemical Examination of Water from the Well of the Sharon Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.	1887.											
128	June 16	June 17	Very slight.	None.	0.0	8.75	–	–	.0000	.0016	.88	.1950	–
349	July 18	July 19	None.	None.	0.0	9.10	–	–	.0000	.0008	.87	.0650	–
557	Aug. 16	Aug. 16	None.	None.	0.0	8.55	–	–	.0000	.0002	.75	.2270	–
749	Sept. 13	Sept. 13	None.	None.	0.0	8.02	–	–	.0000	.0004	.84	.1040	–
956	Oct. 14	Oct. 14	None.	None.	0.0	7.85	–	–	.0000	.0000	.84	.1950	–
1181	Nov. 14	Nov. 14	None.	Sli't, white.	0.0	8.45	–	–	.0000	.0002	.87	.1300	–
1414	Dec. 15	Dec. 16	None.	None.	0.0	7.35	–	–	.0000	.0008	.87	.2800	–
	1888.	1888.											
1596	Jan. 16	Jan. 17	None.	None.	0.0	7.75	–	–	.0000	.0000	.84	.2250	.0001
1799	Feb. 11	Feb. 11	None.	None.	0.0	7.50	–	–	.0006	.0020	.84	.2000	.0002
2055	Mar. 20	Mar. 20	None.	None.	0.0	7.45	–	–	.0000	.0010	.82	.2250	.0000
2283	Apr. 23	Apr. 23	None.	None.	0.0	7.25	–	–	.0000	.0008	.77	.1900	.0000
2498	May 23	May 24	None.	None.	0.0	7.80	–	–	.0000	.0000	.79	.2250	.0000
Av.	....	....	....	....	0.0	7.99			.0001	.0007	.83	.1884	.0001

Hardness in May, 1888, 3.4. Odor, none.—— The samples were collected from a faucet on the main pipe near the pumping station while pumping.

Microscopical Examination.

March, April, May, 1888. No organisms.

Chemical Examination of Water from the Tank of the Sharon Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.	1887.											
955	Oct. 14	Oct. 14	None.	None.	0.0	7.90	–	–	.0000	.0000	.83	.2270	.0001
	1888.	1888.											
1597	Jan. 16	Jan. 17	None.	None.	0.0	7.45	–	–	.0000	.0000	.85	.2250	.0000
1800	Feb. 11	Feb. 11	Very slight.	None.	0.0	7.75	–	–	.0000	.0024	.76	.1800	.0002
Av.	....	....	....	....	0.0	7.70	–	–	.0000	.0008	.81	.2107	.0001

Odor, none.—— The samples were collected from a faucet about one-quarter of a mile beyond the tank, and represent water that had passed through the tank.

Chemical Examination of Water from Mann's Pond, Sharon.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
4248	Mar. 8	Mar. 8	Very slight.	Very slight.	0.2	2.75	1.10	1.65	.0012	.0140 .0140	.24	.0550	.0001

Odor, very faint or none.——The sample was collected from Mann's Mill Pond on Sapoo Brook just below Massapoag Lake.

Water Supply of Shelburne.

Description of Works. — Population in 1885, 1,614. The town is supplied with spring water from the hills about the town by several small aqueduct companies. Two of these companies supply 40 to 50 families each in the village of Shelburne Falls. The Covell Aqueduct Company is one of the principal companies, and first introduced water in 1885. The source of supply is a spring, and water is distributed by gravity. The distributing mains and service pipes are of wrought iron.

Water Supply of the Reformatory Prison for Women at Sherborn.

This is a supply to a public institution, which has a population of about 250 people. The source of supply is Waushakum Pond in Framingham. Water flows by gravity to a pump-well near the prison, and thence is pumped to an iron tank 10 feet square and 8 feet in depth in the prison. This pond is within the drainage area of Lake Cochituate, and therefore contributes to the water supply of Boston.

Chemical Examination of Water from a Faucet at the Reformatory Prison for Women, Sherborn, supplied from Waushakum Pond.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
205	June 27	June 28	Decided.	None.	0.50	4.70	1.55	3.15	.0015	.0161	.29	.0060	–
404	July 26	July 27	Very slight.	Slight.	0.35	4.52	1.02	3.50	.0010	.0178	.29	.0130	–
650	Aug. 31	Sept. 1	Very slight.	None.	0.15	4.13	1.08	3.05	.0004	.0200	.25	.0000	–

Chemical Examination of Water from a Faucet at the Reformatory Prison for Women, Sherborn, supplied from Waushakum Pond — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
1058	Oct. 27	Oct. 28	Slight.	Very slight.	0.20	4.05	1.05	3.00	.0010	.0180	.28	.0020	-
1235	Nov. 21	Nov. 22	Very slight.	Sli't, white.	0.20	4.45	1.20	3.25	.0008	.0178	.30	.0040	-
1454	Dec. 20	Dec. 21	Slight.	Very slight.	0.10	3.80	0.85	2.95	.0005	.0190	.28	.0030	.0000
	1888.												
1655	Jan. 20	Jan. 21	Slight.	Very slight.	0.20	4.45	1.45	3.00	.0010	.0204	.26	.0120	.0000
2247	Apr. 18	Apr. 19	Slight.	Very slight, white.	0.30	4.00	0.95	3.05	.0015	.0207	.25	.0120	.0003
2516	May 26	May 26	Slight.	Very slight.	0.40	4.25	1.30	2.95	.0006	.0212	.25	.0030	.0001
Av.	....	....	....	....	0.23	4.16	1.13	3.03	.0009	.0195	.27	.0060	.0001

Hardness in May, 1888, 2.0. Odor, very faint or none.—— The samples were collected from a faucet at the pumping station while pumping, with the exception of Nos. 1454 and 1655, which were collected from faucets in the building, and No. 650, which was collected from the pond itself.

Microscopical Examination.

	1888. March.	1888. April.	1888. May.
1. Blue-green Algæ, ...	0.0	0.0	0.0
2. Other Algæ, ...	pr.	pr.	pr.
3. Fungi, ...	0.0	0.0	0.0
4. Animal Forms, ...	pr.	pr.	0.0

Groups and principal genera of organisms observed: 2. Diatomaceæ; Desmidiaceæ. 4. Protozoa.

Water Supply of Somerville.

Description of Works. — Population in 1885, 29,971. The distributing system is owned by the city. Water was introduced in 1867. The source of supply is Upper Mystic Lake. For a description of the source of supply and analyses of the water, see Boston, *Mystic Works*.

WATER SUPPLY OF SOUTHBRIDGE. — SOUTHBRIDGE WATER COMPANY.

Description of Works. — Population in 1885, 6,500. The works are owned by the Southbridge Water Company, and were built in 1880. About 100 families were supplied in 1887. The source of supply is a reservoir on a small brook in Southbridge. The area of this reservoir is about five acres. Portions of it are very shallow, and the bottom is generally muddy. The watershed is said to contain about 200 acres, and consists mostly of pasture and woodland. Water is distributed by gravity. Distributing mains are of cast iron. Service pipes are of wrought iron coated with tar.

Chemical Examination of Water from a Drinking Fountain in Southbridge, supplied from the Works of the Southbridge Water Company.

[Parts per 100,000.]

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.
	1887.												
216	June 28	June 29	Distinct.	Sli't, white.	0.45	3.80	1.25	2.55	.0023	.0248	.13	.0000	-
431	July 28	July 29	Very slight.	Slight.	0.80	4.57	1.55	3.02	.0012	.0231	.13	.0050	-
644	Aug. 30	Aug. 31	Very slight.	Very slight, brown.	0.70	4.22	1.25	2.97	.0031	.0238	.10	.0070	-
843	Sept. 22	Sept. 23	Very slight.	Very slight.	0.30	4.50	1.35	3.15	.0014	.0198	.11	.0030	-
1059	Oct. 27	Oct. 28	Slight.	Sli't, white.	0.30	4.15	0.80	3.35	.0003	.0220	.15	.0000	-
1326	Dec. 5	Dec. 6	Very slight.	Sli't, brown.	0.25	4.20	1.35	2.85	.0002	.0180	.19	.0020	-
1504	Dec. 29	Dec. 30	Slight.	None.	0.30	3.75	0.90	2.85	.0027	.0159	.21	.0050	-
	1888.												
1699	Jan. 30	Jan. 31	Very slight.	Very slight.	0.20	3.30	0.75	2.55	.0036	.0094	.09	.0080	.0000
1917	Feb. 28	Mar. 1	Distinct.	Very slight, white.	0.30	3.20	0.75	2.45	.0080	.0118	.14	.0080	.0001
2114	Mar. 27	Mar. 28	Very slight.	None.	0.20	2.40	0.80	1.60	.0002	.0122	.15	.0050	.0001
2324	Apr. 27	Apr. 30	Slight.	Sli't, brown.	0.10	2.35	0.65	1.70	.0018	.0140	.14	.0050	.0000
2536	May 29	May 31	Slight.	Sli't, brown.	0.30	3.00	0.85	2.15	.0008	.0156	.10	.0030	.0001
2690	June 28	June 29	Distinct.	Sli't, brown.	0.30	3.95	1.35	2.60	.0004	.0262 .0244	.12	.0020	.0000
2856	July 27	July 30	Very slight.	Very slight.	0.10	3.60	0.70	2.90	.0002	.0230 .0196	.08	.0030	.0000
3030	Aug. 23	Aug. 25	Very slight	Con., earthy and floc't.	0.20	3.50	1.25	2.25	.0004	.0276 .0202	.06	.0030	.0000
3284	Sept. 27	Sept. 29	Slight.	Sli't, earthy and floc't.	0.25	3.65	1.60	2.05	.0012	.0260 .0208	.13	.0030	.0003
3468	Oct. 29	Oct. 31	Slight.	Slight.	0.20	3.40	1.05	2.35	.0008	.0150 .0120	.15	.0060	.0002

Chemical Examination of Water from a Drinking Fountain in Southbridge, supplied from the Works of the Southbridge Water Company — Concluded.

Number.	Date of Collection.	Date of Exam-ination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albu-minoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
3686	Dec. 8	Dec. 11	Slight.	Slight.	0.05	3.05	0.75	2.30	.0014	.0152 .0100	.16	.0070	.0004
3752	Dec. 18	Dec. 20	Decided.	Heavy, flocculent.	0.15	4.30 2.75	0.90 0.80	3.40 1.95	.0002	.0148 .0104	.11	.0070	.0003
	1889.												
3908	Jan. 22	Jan. 24	Sli't, milky.	Sli't, white.	0.10	2.45	0.60	1.85	.0006	.0110 .0084	.11	.0080	.0001
4127	Feb. 25	Feb. 27	Very slight.	Con., reddish brown.	0.10	3.20	1.05	2.15	.0012	.0110 .0090	.14	.0070	.0000
4426	Mar. 27	Mar. 29	Very slight.	Very slight.	0.10	2.55	0.55	2.00	.0000	.0130 .0082	.10	.0030	.0001
4594	May 1	May 2	Distinct.	Consid'ble.	0.10	3.10	0.95	2.15	.0014	.0170 .0124	.14	.0040	.0000
4733	May 22	May 24	Slight.	Heavy.	0.10	3.25	1.00	2.25	.0000	.0234 .0140	.12	.0040	.C002
Av.	....	....	....	....	0.25	3.67	1.01	2.66	.0014	.0181	.13	.0045	.0001

Hardness in May, 1888, 1.4. Odor, faintly vegetable. —— The samples were collected from a drinking fountain in the village.

Microscopical Examination.

	1888. July.	1888. Aug.	1888. Sept.	1888. Oct.	1888. Dec.	1888. Dec.	1889. Jan.	1889. Feb.	1889. Mar.	1889. Apr.	1889. May.
1. Blue-green Algæ, ...	0.0	0.0	0.0	0.0	0.0	pr.	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	3.4	3.4	0.6	5.0	pr.	pr.	pr.	0.3	0.2	pr.	0.1
3. Fungi, ...	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.2	0.0	1.0
4. Animal Forms, ...	0.3	pr.	pr.	0.0	0.0	0.0	pr.	pr.	1.0	0.2	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ, *Chlorococcus;* Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Synedra;* Zygnemaceæ. 3. Schizomycetes, *Crenothrix*. 4. Protozoa, *Dinobryon;* Spongiaria; Rotifera; Entomostraca.

Water Supply of South Hadley Falls Fire District, South Hadley.

Description of Works. — Population of the town of South Hadley in 1885, 3,949. The works are owned by the Fire District, and were built in 1872. About 500 families were supplied in 1887. The source of supply is Buttery Brook in South Hadley, on which a small reservoir is built. The area of the reservoir is about 2 acres and its maximum depth about 12 feet. The general depth of

the reservoir is about 8 feet. The bottom was cleaned and covered with sand in 1886. The upper portion of the watershed is somewhat swampy, and contains a few small ponds. The lower portion is pasture land. Water is distributed by gravity. Distributing mains are of cast iron. Service pipes are of lead.

Chemical Examination of Water from a Faucet in South Hadley, supplied from the South Hadley Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
188	June 23	June 24	Decided.	Con.,brown.	0.50	4.47	0.87	3.60	.0006	.0143	.18	.0130	–
398	July 25	July 26	Decided.	Sli't,earthy.	1.20	4.80	1.67	3.13	.0015	.0221	.12	.0160	–
647	Aug. 30	Aug. 31	Very slight.	None.	0.40	3.65	0.52	3.13	.0000	.0074	.13	.0130	–
852	Sept. 23	Sept. 24	Decided.	Sli't,brown.	0.30	3.70	0.70	3.00	.0004	.0059	.12	.0090	–
1023	Oct. 24	Oct. 25	Slight.	Sli't,brown.	0.30	3.65	0.55	3.10	.0000	.0042	.15	.0100	–
1319	Dec. 2	Dec. 5	Decided.	Very slight, brown.	0.20	3.65	0.85	2.80	.0006	.0076	.10	.0200	–
1487	Dec. 27	Dec. 28	Slight.	Very slight, white.	0.20	3.55	0.50	3.05	.0022	.0066	.13	.0200	–
	1888.												
1694	Jan. 25	Jan. 26	Sli't,milky.	Very slight.	0.10	3.25	0.35	2.90	.0032	.0048	.08	.0050	.0001
1913	Feb. 27	Feb. 29	Slight.	Very slight.	0.40	3.05	0.95	2.10	.0027	.0084	.11	.0150	.0000
2113	Mar. 26	Mar. 28	Slight.	Con.,brown.	0.40	3.65	0.80	2.85	.0007	.0118	.09	.0100	.0000
2318	Apr. 25	Apr. 27	Slight.	Con.,brown.	0.20	2.90	0.75	2.15	.0002	.0069	.11	.0200	.0002
2531	May 28	May 29	Slight.	Very slight, earthy.	0.45	3.05	0.60	2.45	.0000	.0064	.14	.0080	.0001
Av.	....	....	....	....	0.39	3.61	0.76	2.85	.0010	.0089	.12	.0133	.0001

Hardness in May, 1888, 1.2. Odor, very faintly vegetable.—— The samples were collected from a faucet in the village of South Hadley Falls. There were heavy rains just previous to the collection of Nos. 188 and 398.

Microscopical Examination.

	1888. March.	1888. April.	1888. May.
1. Blue-green Algæ,	0.0	0.0	0.0
2. Other Algæ,	pr.	pr.	0.0
3. Fungi,	0.0	0.0	0.0
4. Animal Forms,	0.0	pr.	0.0

Groups and principal genera of organisms observed: 2. Zoosporeæ; Desmidiaceæ; Diatomaceæ. 4. Protozoa.

Water Supply of Spencer.

Description of Works. — Population in 1885, 8,247. The works were built in 1883 by the Spencer Water Company, and were purchased by the town July 1, 1884. The estimated population supplied in 1886 was about 6,000. The source of supply is Shaw Pond in Leicester. The area of the pond is 67 acres. About one-third of it is less than 10 feet in depth at high water. There is a dam at the outlet of the pond. The watershed of the pond is said to consist principally of pasture land with a small amount of woodland. Its area, exclusive of the area of the pond, is about 155 acres. Water is distributed by gravity. Distributing mains are of wrought iron lined with cement. Service pipes are of galvanized iron. In 1886 there were complaints of a disagreeable taste and odor in the water supplied to consumers.

Chemical Examination of Water from a Faucet in Spencer, supplied from Shaw Pond.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
112	June 15	June 16	Sli't, milky.	Sli't, brown.	0.00	3.32	1.20	2.12	.0013	.0115	.13	.0000	-
441	July 29	July 29	None.	None.	0.05	2.85	0.47	2.38	.0007	.0113	.12	.0070	-
519	Aug. 11	Aug. 11	Slight.	Very slight.	0.15	2.80	1.05	1.75	.0002	.0152	.20	.0130	-
855	Sept. 26	Sept. 28	Very slight.	None.	0.00	2.75	0.90	1.85	.0005	.0177	.09	.0030	-
978	Oct. 18	Oct. 19	Slight.	None.	0.00	2.20	0.50	1.70	.0000	.0144	.15	.0030	-
1363	Dec. 8	Dec. 9	Very slight.	None.	0.00	2.30	1.05	1.25	.0010	.0126	.16	.0080	-
	1888.												
1912	Feb. 29	Feb. 29	Very slight.	None.	0.00	2.60	0.80	1.80	.0012	.0124	.16	.0070	.0001
Av.	....	....	....	....	0.03	2.69	0.	1.84	.0007	.0136	.14	.0059	-

Odor, very faintly vegetable. —— The samples were collected from a faucet in the village.

Water Supply of Springfield.

Description of Works. — Population in 1885, 37,575. The works are owned by the city, and were constructed in 1874 and 1875. The average daily consumption in 1888 is estimated to have been 4,000,000 gallons. The main source of supply is a storage reservoir in the town of Ludlow. When full, this reservoir has an area of 445

acres, and contains 1,992,000,000 gallons. Its maximum depth is about 24 feet and its average depth 13.7 feet. Of the area flowed by the reservoir 281 acres were covered with wood in various stages of growth. A part of this area was low, swampy land, — the mud or peaty deposit ranging from 6 inches to 4 feet in depth. These peaty areas are not less than 12 feet below high-water mark, and most of them are as much as 16 feet below. The stumps were cut low and all wood and brush was burned, and the stumps were charred. Six and three-eighths acres of the most objectionable portion of the swamp were sanded over to a depth of nearly 1.5 feet. The shores are as a rule abrupt, the exception to the rule being at the upper end of the reservoir, where a comparatively small area is quite shallow.

The Ludlow Reservoir is fed by a direct watershed of 1,188 acres, exclusive of the reservoir. On the west it receives water from Higher Brook through a canal about one mile in length. The watershed of Higher Brook at the point where its water is diverted is 1,119 acres. On the easterly side water is brought into the reservoir by the Broad Brook Canal, which is about 12,000 feet in length. Until Nov. 30, 1886, this canal brought water from the Belchertown Reservoir, a shallow body of water of about 25 or 30 acres, formed by a dam which also floods a large area of swampy land on the brook above the reservoir to a very slight depth. As it was thought that the water from this reservoir, and the swampy land above it, had an injurious effect upon the water in the Ludlow Reservoir, the canal was extended and altered so as to intercept only the north-western branch of Broad Brook, which is known locally as Axe-Factory Brook, the water of Belchertown Reservoir being allowed to run to waste. The area of the Axe-Factory Brook watershed at the point of diversion is 1,655 acres. The total watershed now tributary to Ludlow Reservoir is 4,358 acres. Previous to Nov. 30, 1886, the total watershed was 6,484 acres. These areas contain only a very small population.

Water is conveyed from Ludlow Reservoir to the city through a 24-inch cement-lined wrought-iron pipe. The higher districts are supplied directly from the Ludlow Reservoir. The lower districts are supplied chiefly with Ludlow water, which is turned into two distributing reservoirs, known as the Van Horn and Lombard reservoirs.

The Van Horn Reservoir is separated into two sections by a road

which crosses it, and the sections are known respectively as the Upper and Lower Van Horn reservoirs. Upper Van Horn Reservoir has an area of about 9.5 acres, and its capacity at high water is 28,000,000 gallons. Its maximum depth is 23 feet. Lower Van Horn Reservoir has an area of 13.5 acres, and its capacity is 74,000,-000 gallons. Its maximum depth is 30 feet. The Upper and Lower Van Horn reservoirs are connected, and are operated as one reservoir. This reservoir has a considerable watershed of its own, estimated at 250 acres more or less, mostly an elevated sandy plain, from which much of the water enters the reservoir by filtration through the ground. The Ludlow water is supplied to this reservoir through an 8-inch pipe which ends in a ditch in the elevated sandy plain beside the reservoir. The water is allowed to flow through this ditch for a distance of about 500 feet, and then flows swiftly through a trough having a steep grade, and at the end falls about 10 feet.

Lombard Reservoir has an area of nearly three acres, and its capacity is about 9,000,000 gallons. It also has a small drainage area of its own which is similar to that of the Van Horn Reservoir.

The distributing mains originally laid were of wrought iron lined with cement, but cast iron is now used for extensions and in all cases where it becomes necessary to relay existing mains. Service pipes are of wrought iron coated with tar.

From the year of the first introduction of Ludlow water into Springfield to the present time the water in the summer has had a disagreeable taste and odor. This trouble was specially investigated in the summer and autumn of 1889, and will be discussed in a subsequent portion of this report.

Chemical Examination of Water from Ludlow Reservoir, Springfield Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
203	June 24	June 27	Slight.	Slight.	0.25	2.90	1.00	1.90	.0004	.0304	.16	.0000	–
409	July 26	July 27	Slight.	Very slight.	0.20	–	–	–	.0114	.0260	.13	.0020	–
619	Aug. 25	Aug. 26	Distinct.	Very slight.	0.50	4.20	2.25	1.95	.0085	.0910	.20	.0030	–

Chemical Examination of Water from Ludlow Reservoir, Springfield Water Works — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
826	Sept. 20	Sept. 21	Distinct.	Consid'ble.	0.30	4.10	1.60	2.50	.0009	.0640	.11	.0030	–
1038	Oct. 24	Oct. 26	Distinct.	Slight.	0.10	4.45	2.40	2.05	.0000	.0684	.12	.0000	–
1263	Nov. 28	Nov. 29	Distinct.	Sli't, white.	0.20	3.15	1.20	1.95	.0000	.0300	.19	.0030	–
1483	Dec. 27	Dec. 28	Very slight.	Very slight, white.	0.15	2.95	1.45	1.50	.0000	.0302	.13	.0020	–
	1888.												
1691	Jan. 25	Jan. 26	Decided.	Very slight.	0.30	4.30	2.10	2.20	.0000	.0500	.08	.0060	.0000
1899	Feb. 27	Feb. 28	Distinct.	None.	0.20	3.70	1.75	1.95	.0023	.0314	.15	.0090	.0000
2110	Mar. 26	Mar. 28	Distinct.	Very slight.	0.20	2.25	0.85	1.40	.0054	.0228	.10	.0030	.0000
2304	Apr. 25	Apr. 26	Distinct.	Very slight, green.	0.15	2.85	1.00	1.85	.0059	.0245	.11	.0030	.0001
2507	May 24	May 25	Decided.	Very slight.	0.20	3.10	1.15	1.95	.0000	.0238 .0164	.12	.0030	.0003
2671	June 25	June 27	Distinct.	Slight.	0.10	2.50	0.95	1.55	.0006	.0246 .0222	.11	.0070	.0000
2827	July 23	July 25	Distinct.	Sli't, yellow.	0.10	2.70	1.05	1.65	.0042	.0332 .0220	.13	.0020	.0001
2995	Aug. 20	Aug. 21	Distinct.	Con., green.	0.05	2.80	0.95	1.85	.0006	.0486 .0198	.09	.0030	.0004
3253	Sept. 24	Sept. 25	Slight.	Con., green.	0.00	2.85	1.30	1.55	.0000	.0428 .0206	.12	.0020	.0002
3432	Oct. 22	Oct. 24	Slight.	Con., green.	0.05	2.50	1.10	1.40	.0010	.0440 .0228	.12	.0030	.0001
3590	Nov. 22	Nov. 23	Distinct.	Slight.	0.10	2.60	1.35	1.25	.0022	.0284 .0182	.13	.0100	.0002
3747	Dec. 18	Dec. 19	Distinct.	Sli't, green.	0.15	2.75	0.90	1.85	.0000	.0242 .0164	.13	.0050	.0002
	1889.												
3906	Jan. 22	Jan. 24	Distinct.	Sli't, green.	0.05	2.10	1.00	1.10	.0002	.0232 .0166	.10	.0030	.0004
4154	Feb. 27	Feb. 28	Slight.	Sli't, white.	0.10	2.65	1.30	1.35	.0000	.0268 .0196	.13	.0020	.0003
4400	Mar. 26	Mar. 27	Slight.	Con., light green.	0.20	2.30	1.05	1.25	.0002	.0224 .0180	.08	.0030	.0002
4565	Apr. 23	Apr. 24	Slight.	Con., green.	0.05	2.45	1.00	1.45	.0000	.0274 .0166	.09	.0030	.0002
4652	May 13	May 14	Distinct.	Consid'ble.	0.05	2.70	1.15	1.55	.0002	.0344 .0178	.10	.0150	.0003
4699	May 20	May 21	Decided.	Con., light green.	0.00	2.50	0.95	1.55	.0046	.0468 .0204	.11	.0030	.0001
4748	May 27	May 28	Decided.	Heavy.	0.10	–	–	–	.0000	.0702 .0224	.10	.0030	.0006
Av.	....	....	....	....	0.15	3.45	1.52	1.93	.0019	.0381	.12	.0039	.0002

Hardness in May, 1888, 1.1.——The samples were collected from the reservoir at the gate-house. For a record of heights of water in this reservoir at times when samples of water were collected for analysis, see page 300.

Microscopical Examination.

	1888.							1889.						
	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	May.	May.
1. Blue-green Algæ,	0.4	3.0	6.4	0.4	3.6	0.0	0.0	0.0	0.0	0.0	0.5	0.7	0.2	3.8
2. Other Algæ,	2.5	3.8	0.1	0.4	6.8	38.2	22.0	84.9	3.1	63.0	86.3	0.8	17.6	0.0
3. Fungi,	0.0	0.0	0.0	-0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms,	pr.	1.5	pr.	pr.	0.0	0.8	0.1	0.9	1.2	2.4	1.5	pr.	3.1	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ, *Clathrocystis*, *Anabæna*. 2. Palmellaceæ; Zoosporeæ, *Raphidium*, *Scenedesmus;* Desmidiaceæ, *Staurastrum;* Diatomaceæ, *Asterionella*, *Melosira*, *Stephanodiscus*, *Synedra*, *Tabellaria;* Volvocineæ. 4. Protozoa, *Dinobryon*, *Trachelomonas;* Spongiaria; Rotifera; Entomostraca.

Record of Heights of Water in Ludlow Reservoir at Times when Samples of Water were collected for Analysis.

NOTE: Height of rollway, 23.00 feet.

DATE.	Height of Water.	DATE.	Height of Water.
1887.		**1888.**	
June 24,	21.80	July 23,	21.48
July 26,	21.00	August 20,	20.56
August 25,	20.62	September 24,	20.58
September 20,	19.75	October 22,	21.14
October 24,	18.90	November 22,	21.58
November 28,	18.52	December 18,	22.00
December 27,	19.00	**1889.**	
1888.		January 22,	21.60
January 25,	19.88	February 27,	20.95
February 27,	20.68	March 26,	21.12
March 26,	21.82	April 23,	21.12
April 25,	23.10	May 13,	20.81
May 24,	23.00	May 20,	20.58
June 25,	22.42	May 27,	20.61

Chemical Examination of Water from Ludlow Reservoir, at a Depth of Six Feet beneath the Surface.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Exam-ination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albu-minoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
4566	Apr. 23	Apr. 24	Slight.	Con., green.	0.10	2.35	0.85	1.50	.0000	.0258 .0162	.10	.0020	.0003
4653	May 13	May 14	Distinct.	Slight.	0.05	2.40	1.10	1.30	.0000	.0346 .0180	.09	.0030	.0002
4700	May 20	May 21	Distinct.	Heavy, light green.	0.00	2.40	0.90	1.50	.0006	.0532 .0204	.10	.0020	.0000
4749	May 27	May 28	Decided.	Heavy.	0.10	–	–	–	.0002	.0600 .0214	.10	.0020	.0006
Av.	....	....	....	....	0.06	2.38	0.95	1.43	.0002	.0434 .0190	.10	.0023	.0003

The samples were collected from the centre of the reservoir from 4 to 6 feet beneath the surface.

Microscopical Examination.

	1889.			
	Apr.	May.	May.	May.
1. Blue-green Algæ,	0.5	0.3	3.7	2.4
2. Other Algæ,	71.0	0.2	0.9	0.1
3. Fungi,	0.0	0.0	0.0	0.0
4. Animal Forms,	1.3	pr.	pr.	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ, *Anabæna*. 2. Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Asterionella*, *Melosira*, *Synedra*. 4. Protozoa, *Dinobryon;* Rotifera; Entomostraca.

Chemical Examination of Water from Ludlow Reservoir, collected 18 Feet beneath the Surface.

[Parts per 100,000.]

Number.	Date of — Collection.	Date of — Examination.	Appearance. — Turbidity.	Appearance. — Sediment.	Appearance. — Color.	Residue on Evaporation. — Total.	Residue on Evaporation. — Loss on Ignition.	Residue on Evaporation. — Fixed.	Ammonia. — Free.	Ammonia. — Albuminoid.	Chlorine.	Nitrogen as — Nitrates.	Nitrogen as — Nitrites.
	1889.												
4654	May 13	May 14	Slight.	Consid'ble.	0.10	2.35	1.05	1.30	.0030	.0226 .0168	.12	.0020	.0002
4701	May 20	May 21	Distinct.	Heavy, light green.	0.00	2.80	0.90	1.90	.0044	.0328 .0174	.11	.0030	.0001
4750	May 27	May 28	Distinct.	Heavy.	0.20	–	–	–	.0138	.0288 .0170	.12	.0020	.0006
Av.	....	....	....	... .	0.10	–	–	–	.0071	.0281 .0171	.12	.0023	.0003

The samples were collected from the middle of the reservoir.

Microscopical Examination.

	1889.		
	May 13.	May 21.	May 28.
1. Blue-green Algæ,	0.2	2.3	0.4
2. Other Algæ,	62.0	4.2	0.5
3. Fungi,	0.0	0.0	0.0
4. Animal Forms,	pr.	pr.	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ, *Anabæna*. 2. Zoosporeæ, *Scenedesmus;* Desmidiaceæ; Diatomaceæ, *Asterionella*, *Melosira*. 4. Protozoa; Entomostraca.

Chemical Examination of Water from Broad Brook Canal near the point where it enters Ludlow Reservoir.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1889.												
4563	Apr. 23	Apr. 24	Slight.	Slight, flocculent.	0.5	3.35	1.10	2.25	.0012	.0228 .0172	.12	.0020	.0002
4747	May 27	May 28	Very slight.	Very slight.	0.8	4.20	1.85	2.35	.0022	.0206 .0198	.07	.0030	.0005

Odor, faintly vegetable.

Microscopical Examination.

April, 1889. 1. Blue-green algæ, 0.0; 2. Other algæ, 3.1; 3. Fungi, 0.0; 4. Animal forms, 0.0.
May, 1889. 1. Blue-green algæ, pr.; 2. Other algæ, 0.4; 3. Fungi, 0.0; 4. Animal forms, 0.0.
Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Diatomaceæ, *Tabellaria*.

Chemical Examination of Water from Higher Brook Canal near the point where it enters Ludlow Reservoir.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1889.												
4564	Apr. 23	Apr. 24	Very slight.	Very slight.	0.7	2.55	0.95	1.60	.0002	.0144 .0124	.07	.0020	.0002
4746	May 27	May 28	None.	Very slight.	0.7	3.45	1.65	1.80	.0032	.0212 .0158	.06	.0020	.0006

Odor, faintly vegetable. —— The samples were collected from the canal 100 feet from its entrance to Ludlow Reservoir.

Microscopical Examination.

April, 1889. 1. Blue-green algæ, 0.0; 2. Other algæ, 0.7; 3. Fungi, 0.0; 4. Animal forms, 0.0.
May, 1889. 1. Blue-green algæ, 0.0; 2. Other algæ, 0.2; 3. Fungi, 0.0; 4. Animal forms, 0.0.
Groups and principal genera of organisms observed: 2. Desmidiaceæ; Diatomaceæ.

Chemical Examination of Water from Lombard Reservoir, Springfield.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
196	June 24	June 25	Slight.	None.	0.00	3.57	0.97	2.60	.0007	.0161	.22	.0000	–
407	July 25	July 27	Slight.	Con.,e'rthy.	0.10	3.58	0.27	3.31	.0009	.0154	.28	.0000	–
620	Aug. 24	Aug. 26	Very slight.	None.	0.00	3.22	0.72	2.50	.0010	.0158	.22	.0000	–
828	Sept. 20	Sept. 21	Slight.	Consid'ble.	0.08	3.80	0.65	3.15	.0004	.0616	.10	.0000	–
1037	Oct. 24	Oct. 26	Slight.	Slight.	0.20	3.70	0.70	3.00	.0000	.0114	.33	.0070	–
1262	Nov. 28	Nov. 29	Slight.	Sli't, white.	0.10	3.80	0.70	3.10	.0000	.0086	.41	.0150	–
1482	Dec. 27	Dec. 28	Very slight.	None.	0.10	4.05	0.80	3.25	.0000	.0138	.36	.0120	.0002
	1888.												
1690	Jan. 25	Jan. 26	Distinct.	Very slight.	0.10	4.10	0.95	3.15	.0020	.0146	.20	.0300	.0001
1898	Feb. 27	Feb. 28	Slight.	None.	0.15	2.75	0.50	2.25	.0062	.0113	.18	.0180	.0001
2109	Mar. 26	Mar. 28	Distinct.	Slight.	0.20	3.00	0.50	2.50	.0047	.0190	.16	.0150	.0010
2303	Apr. 25	Apr. 26	Distinct.	Very slight.	0.00	2.95	0.65	2.30	.0000	.0086	.23	.0250	.0003
2506	May 24	May 25	Distinct.	Slight.	0.10	2.85	0.75	2.10	.0024	.0134	.20	.0180	.0003
Av.	....	....	....	....	0.09	3.45	0.68	2.77	.0015	.0175	.24	.0117	.0003

Hardness in May, 1888, 1.1. Odor, vegetable and often mouldy and disagreeable.——The samples were collected from the reservoir near the surface.

Microscopical Examination.

	1888. March.	1888. April.	1888. May.
1. Blue-green Algæ,	0.0	0.0	0.0
2. Other Algæ,	pr.	pr.	pr.
3. Fungi,	0.0	0.0	0.0
4. Animal Forms,	pr.	pr.	pr.

Groups and principal genera of organisms observed: 2. Palmellaceæ; Desmidiaceæ; Diatomaceæ. 4. Protozoa.

Chemical Examination of Water from Van Horn Reservoir, Springfield.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
195	June 24	June 25	Decided.	Slight.	0.50	3.32	1.15	2.17	.0000	.0329	.17	.0000	–
408	July 25	July 27	Decided.	Very slight.	0.10	3.60	1.30	2.30	.0055	.0461	.17	.0000	–
622	Aug. 24	Aug. 27	Decided.	None.	0.25	3.97	1.55	2.42	.0032	.0574	.22	.0000	–
827	Sept. 20	Sept. 21	Distinct.	Slight.	0.05	3.60	0.95	2.65	.0200	.0371	.14	.0030	–
1039	Oct. 24	Oct. 26	Slight.	Slight.	0.20	3.30	0.80	2.50	.0324	.0242	.17	.0200	–
1264	Nov. 28	Nov. 29	Distinct.	Sli't, white.	0.05	3.55	1.15	2.40	.0200	.0232	.19	.0300	–
1484	Dec. 27	Dec. 28	Slight.	Very slight, white.	0.10	3.75	1.50	2.25	.0184	.0233	.20	.0400	.0002
	1888.												
1692	Jan. 25	Jan. 26	Distinct.	Slight.	0.10	4.05	1.65	2.40	.0087	.0359	.15	.0180	.0001
1900	Feb. 27	Feb. 28	Distinct.	Very slight.	0.20	2.95	1.05	1.90	.0166	.0190	.16	.0300	.0003
2111	Mar. 27	Mar. 28	Distinct.	Sli't, dark brown.	0.20	3.00	0.75	2.25	.0091	.0250	.14	.0180	.0002
2305	Apr. 25	Apr. 26	Distinct.	Very slight, white.	0.10	3.00	0.70	2.30	.0054	.0180	.16	.0400	.0002
2508	May 24	May 25	Distinct.	Very slight.	0.10	2.65	0.75	1.90	.0006	.0180	.11	.0180	.0005
2829	July 23	July 25	Slight.	Sli't, white.	0.00	2.60	0.70	1.90	.0002	.0184 .0130	.15	.0090	.0001
3746	Dec. 18	Dec. 19	Distinct.	Sl't, earthy.	0.20	2.80	1.20	1.60	.0124	.0182 .0120	.16	.0300	.0006
	1889.												
3905	Jan. 22	Jan. 24	Distinct.	Sli't, white.	0.00	2.90	0.75	2.15	.0060	.0180 .0148	.13	.0300	.0003
4153	Feb. 27	Feb. 28	Very slight.	Sli't, white.	0.05	2.95	1.05	1.90	.0060	.0208 .0160	.16	.0280	.0000
4401	Mar. 26	Mar. 27	Slight.	Con., white.	0.10	2.95	0.95	2.00	.0018	.0208 .0140	.09	.0280	.0002
Av.	....	....	....	....	0.14	3.40	1.11	2.29	.0098	.0268	.16	.0201	.0002

Hardness in May, 1888, 1.1. Odor, vegetable, occasionally mouldy. —— The samples were collected from the reservoir at depths varying from 6 inches to 2 feet beneath the surface.

Microscopical Examination.

	1888. July.	1888. Dec.	1889. Jan.	1889. Feb.	1889. Mar.
1. Blue-green Algæ, ...	pr.	0.0	0.0	0.0	0.0
2. Other Algæ, ...	4.5	8.9	3.8	1.4	6.5
3. Fungi, ...	0.7	0.0	0.0	pr.	0.0
4. Animal Forms, ...	0.1	0.0	1.6	0.3	0.4

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ, *Chlorococcus;* Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Asterionella*, *Melosira*, *Staurogenia*. 3. Schizomycetes. 4. Protozoa; Rotifera; Entomostraca.

Chemical Examination of Water from a Faucet in Springfield, supplied from the Ludlow Reservoir.

[Parts per 100,000.]

Number.	Date of — Collection.	Date of — Exam-ination.	Appearance. — Turbidity.	Appearance. — Sediment.	Appearance. — Color.	Residue on Evaporation. — Total.	Residue on Evaporation. — Loss on Ignition.	Residue on Evaporation. — Fixed.	Ammonia. — Free.	Ammonia. — Albu-minoid.	Chlorine.	Nitrogen as — Nitrates.	Nitrogen as — Nitrites.
	1887.												
197	June 24	June 25	Decided.	Consid'ble.	0.70	4.97	2.10	2.87	.0095	.0634	.13	.0060	–
410	July 26	July 27	Decided.	Consid'ble.	0.30	–	–	–	.0025	.0257	.13	.0330	–
621	Aug. 24	Aug. 27	Decided.	Slight.	0.50	4.00	1.85	2.15	.0284	.0612	.18	.0130	–
829	Sept. 23	Sept. 24	Decided.	H'vy, e'rthy and floc't.	0.20	4.25	1.70	2.55	.0030	.0641	.11	.0100	–
1040	Oct. 24	Oct. 26	Slight.	Heavy, green.	0.05	10.15	7.05	3.10	.0022	.2320	.13	.0020	–
1265	Nov. 28	Nov. 29	Distinct.	Sli't, white.	0.10	3.05	1.25	1.80	.0004	.0296	.15	.0060	–
1485	Dec. 27	Dec. 28	Slight.	Sli't, white.	0.20	3.10	1.25	1.85	.0016	.0315	.13	.0080	–
	1888.												
1693	Jan. 25	Jan. 26	Distinct.	Very slight.	0.15	3.20	1.30	1.90	.0032	.0282	.09	.0020	.0000
1901	Feb. 27	Feb. 28	Distinct.	None.	0.10	3.30	1.60	1.70	.0044	.0285	.13	.0050	.0002
2112	Mar. 27	Mar. 28	Distinct.	Very slight.	0.20	3.15	1.10	2.05	.0072	.0284	.12	.0060	.0002
2306	Apr. 25	Apr. 26	Distinct.	Very slight, white.	0.15	3.00	1.15	1.85	.0022	.0224	.12	.0070	.0002
2509	May 24	May 25	Distinct.	Very slight, white.	0.20	2.35	0.95	1.40	.0008	.0212	.10	.0030	.0003
2673	June 25	June 27	Slight.	Sli't, white.	0.20	2.85	1.05	1.80	.0024	.0220 .0218	.07	.0090	.0001
2828	July 23	July 25	Decided.	Sli't, green.	0.10	2.75	1.00	1.75	.0000	.0502 .0202	.12	.0040	.0002
2997	Aug. 20	Aug. 21	Distinct.	Heavy, green.	0.10	3.25	1.35	1.90	.0000	.0536 .0186	.11	.0050	.0003
3254	Sept. 24	Sept. 25	Slight.	Sli't, green.	0.05	3.05	1.30	1.75	.0000	.0322 .0236	.12	.0030	.0002
3433	Oct. 22	Oct. 24	Distinct.	Sli't, green.	0.10	2.65	1.05	1.60	.0032	.0332 .0210	.11	.0040	.0002
3592	Nov. 22	Nov. 23	Sli't, milky.	Sli't, green.	0.05	2.65	1.30	1.35	.0010	.0254 .0212	.13	.0100	.0005
3748	Dec. 18	Dec. 19	Slight.	Sli't, green.	0.20	2.75	0.90	1.85	.0002	.0238 .0166	.10	.0070	.0002
	1889.												
3907	Jan. 22	Jan. 24	Slight.	Slight.	0.10	2.20	0.85	1.35	.0002	.0188 .0164	.10	.0060	.0002
4152	Feb. 27	Feb. 28	Very slight.	Very slight.	0.10	2.45	1.25	1.20	.0000	.0224 .0186	.12	.0030	.0001
4402	Mar. 26	Mar. 27	Very slight.	Very slight.	0.15	2.35	1.10	1.25	.0004	.0196 .0190	.09	.0060	.0001
Av.	....	....	....	....	0.18	4.05	1.94	2.11	.0033	.0426	.12	.0072	.0002

Hardness in May, 1888, 1.1. —— The samples were collected from a faucet in the office of the Springfield Water Commissioners. The faucet is supplied from a tap near the end of a high-service pipe in the low-service district. As water for ordinary purposes is not drawn from this pipe, deposits of algæ occur in it, which are stirred up when a current is produced; consequently the analyses of water collected at this point are very variable.

Microscopical Examination.

	1888.							1889.		
	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
1. Blue-green Algæ,	0.1	2.2	2.8	2.2	0.3	0.1	0.0	0.0	0.0	0.0
2. Other Algæ,	23.0	0.4	0.9	0.9	15.2	14.6	3.0	0.7	1.7	29.9
3. Fungi,	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms,	0.4	pr.	pr.	0.1	0.0	0.3	0.1	pr.	0.1	2.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ, *Aphanocapsa*, *Clathrocystis*. 2. Palmellaceæ, *Chlorococcus*, *Botryococcus*; Zoosporeæ, *Conferva*, *Scenedesmus*; Desmidiaceæ, *Staurastrum*; Diatomaceæ, *Asterionella*, *Melosira*. 3. Schizomycetes. 4. Protozoa, *Dinobryon*; Rotifera; Entomostraca.

Water Supply of Stockbridge. — Stockbridge Water Company.

Description of Works. — Population of the town of Stockbridge in 1885, 2,114. The works from which the main village of Stockbridge is supplied are owned by the Stockbridge Water Company, and were built in 1862 and 1884. The sources of supply are a small reservoir and a tubular well near it on the westerly side of Bear Mountain. The reservoir is fed by a small brook, which is dry much of the year, and by springs. Its capacity is about 94,500 gallons. When the supply from the reservoir is insufficient, water is pumped into it from the tubular well, which is 8 inches in diameter and 300 feet in depth. Both of the sources now in use furnish but a limited supply for the village in a dry time. Another tubular well was sunk on the side of the mountain near the reservoir to a depth of 600 feet, but the amount of water which could be pumped from it was so small that it was abandoned. Water is distributed from the reservoir by gravity. Distributing mains are of cast iron. Service pipes are of galvanized iron.

In addition to the Stockbridge Water Company, two other companies supply small portions of the town of Stockbridge. The Hill Water Company supplies that portion of Stockbridge known as "The Hill." The Lenox Water Company supplies a portion of Stockbridge near Lenox.

Chemical Examination of Water from a Faucet in Stockbridge, supplied from the Works of the Stockbridge Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
252	July 5	July 6	Slight.	Con., brown.	0.00	10.92	–	–	.0007	.0041	.12	.0000	–
473	Aug. 3	Aug. 4	Distinct.	Con., brown.	0.15	10.00	–	–	.0000	.0073	.11	.0000	–
697	Sept. 6	Sept. 7	Slight.	Slight.	0.00	9.87	–	–	.0003	.0009	.08	.0070	–
942	Oct. 12	Oct. 13	None.	None.	0.00	11.15	–	–	.0000	.0012	.05	.0030	–
1117	Nov. 7	Nov. 8	Very slight.	Sli't, earthy, and floc't.	0.00	10.75	–	–	.0000	.0013	.07	.0030	–
1327	Dec. 5	Dec. 6	None.	Sli't, earthy, and floc't.	0.00	9.75	–	–	.0000	.0008	.10	.0020	–
	1888.												
1545	Jan. 5	Jan. 6	None.	Very slight.	0.00	7.45	–	–	.0000	.0026	.09	.0020	.0000
1736	Feb. 2	Feb. 3	None.	None.	0.00	8.30	–	–	.0000	.0014	.11	.0050	.0000
1951	Mar. 5	Mar. 6	Slight.	Slight.	0.00	7.80	–	–	.0000	.0014	.10	.0030	.0000
2155	Apr. 3	Apr. 4	Very slight.	None.	0.00	6.35	–	–	.0007	.0032	.09	.0050	.0000
2352	May 3	May 4	Very slight.	Slight.	0.10	5.45	–	–	.0000	.0008	.08	.0060	.0000
Av.	....	....	....	....	0.02	8.89	–	–	.0002	.0023	.09	.0033	.0000

Hardness in May, 1888, 4.3. Odor, none.—— The samples were collected from a faucet in the village.

Microscopical Examination.

April, May, 1888. 1. Blue-green algæ, 0.0; 2. Other algæ, pr.; 3. Fungi, 0.0; 4. Animal forms, 0.0. Groups and principal genera of organisms observed: 2. Diatomaceæ.

Chemical Examination of Water from Hagar Pond or Mohawk Lake, Stockbridge.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
3990	Feb. 7	Feb. 8	Distinct.	Very slight.	0.00	12.50	0.50	12.00	.0040	.0056 .0044	.09	.0030	.0000

Hardness in February, 1889, 11.5. Odor, very faintly vegetable.—— The sample was collected about 100 feet from shore, through an opening in the ice.

Microscopical Examination.

February, 1889. 1. Blue-green algæ, pr.; 2. Other algæ, pr.; 3. Fungi, 0.0; 4. Animal forms, 2.0. Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Diatomaceæ. 4. Protozoa, *Dinobryon*; Entomostraca.

Chemical Examination of Water from Lake Mahkeenac or Stockbridge Bowl, Stockbridge.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
3991	Feb. 7	Feb. 8	Very slight.	Very slight.	0.02	12.45	1.35	11.10	.0006	.0110 .0078	.16	.0150	.0002

Hardness, 11.5. Odor, faintly vegetable and earthy.—— The sample was collected from the pond near the outlet.

Microscopical Examination.

February, 1889. 1. Blue-green algæ, 0.0; 2. Other algæ, 6.1; 3. Fungi, pr.; 4. Animal forms, 2.1.

Groups and principal genera of organisms observed: 2. Diatomaceæ, *Asterionella*, *Synedra*, *Stephanodiscus*. 3. Schizomycetes. 4. Protozoa, *Dinobryon*.

Water Supply of Stoneham.

This town is supplied jointly with Wakefield by the Wakefield Water Company. *See Wakefield.*

Water Supply of Stoughton. — Stoughton Water Company.

Description of Works. — Population in 1885, 5,173. The works are owned by the Stoughton Water Company, and were built in 1886. The average daily consumption in 1888 was about 40,000 gallons. The source of supply is a well 25 feet in diameter and 30 feet deep, located in the centre of the village. It is built of stone laid in cement, and was excavated partly in ledge. Pumps force the water to the distributing mains and to an open iron tank 30 feet in diameter and 60 feet in height. Distributing mains are of cast iron; service pipes are of lead and of tarred iron.

Chemical Examination of Water from the Well of the Stoughton Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
129	June 16	June 17	None.	None.	0.00	17.77	–	–	.0014	.0053	1.84	1.300	–
360	July 19	July 19	None.	None.	0.00	18.75	–	–	.0000	.0037	2.21	0.980	–
540	Aug. 15	Aug. 15	None.	None.	0.00	17.75	–	–	.0002	.0034	1.97	–	–

Chemical Examination of Water from the Well of the Stoughton Water Company — Concluded.

Number.	Date of Collection.	Date of Exam-ination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albu-minoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
752	Sept. 13	Sept. 13	None.	None.	0.00	17.90	–	–	.0006	.0034	2.10	0.650	–
961	Oct. 15	Oct. 17	Very slight.	None.	0.00	16.50	–	–	.0000	.0016	2.27	0.780	–
1180	Nov. 14	Nov. 14	Distinct.	None.	0.05	15.95	–	–	.0030	.0030	2.12	0.450	–
1411	Dec. 15	Dec. 15	Very slight.	None.	0.00	16.85	–	–	.0020	.0062	2.19	0.750	–
	1888.												
1582	Jan. 12	Jan. 12	Very slight.	Sli't, earthy.	0.00	17.40	–	–	.0018	.0062	2.30	1.000	.0020
1804	Feb. 11	Feb. 13	Distinct, milky.	Sli't, rusty.	0.10	18.85	–	–	.0043	.0041	2.38	0.800	.0140
2053	Mar. 20	Mar. 20	Sli't, milky.	None.	0.00	16.70	–	–	.0012	.0032	1.99	0.850	.0020
2279	Apr. 23	Apr. 23	Very slight.	None.	0.00	16.35	–	–	.0004	.0060	1.86	–	.0020
2493	May 23	May 23	Sli't, milky.	None.	0.00	17.35	–	–	.0002	.0024	1.75	0.720	.0000
Av.	....	....	....	....	–	17.34	–	–	.0013	.0040	2.08	0.828	.0040

Hardness in May, 1888, 5.1. Odor, generally none, occasionally faintly mouldy.——The samples were collected from a faucet in the village.

Microscopical Examination.

	1888. March.	1888. April.	1888. May.
1. Blue-green Algæ,	0.0	0.0	0.0
2. Other Algæ,	0.0	pr.	0.0
3. Fungi,	0.0	0.0	0.0
4. Animal Forms,	0.0	pr.	0.0

Groups and principal genera of organisms observed: 2. Diatomaceæ. 4. Protozoa.

Water Supply of Swampscott.

Description of Works. — Population in 1885, 2,471. The distributing system is owned by the town. Water is supplied by the Marblehead Water Company. Distributing mains are of wrought iron lined with cement. Service pipes are of wrought iron, tarred, and of galvanized iron.

Marblehead Water Company.

Description of Works. — This company supplies water to the towns of Marblehead, Swampscott and Nahant, which had an aggregate population in 1885 of 10,625; also to a small part of the city of Lynn. The average daily consumption in 1888 was 220,500 gallons. The main source of supply is a large well, 22 feet in diameter and 20 feet in depth, on the bank of Stacy's Brook in Swampscott. The centre of the well is about 35 feet from the brook. In the bottom of the well are six two-inch tubular wells, sunk to a further depth of 50 to 75 feet. A supplementary supply is obtained from some tubular wells near the brook, a short distance above the pumping station. Pumps force the water from the well to the distributing mains and to an open iron tank 22.5 feet in diameter and 110 feet in height. The distributing mains owned by the company are of cast iron. Stacy's Brook above a point opposite the well receives so much sewage from the very large population on its watershed in the city of Lynn that its waters are highly polluted. A sewer was built in Lynn to intercept the ordinary flow of this brook, but it was not in operation when the samples were collected from the brook. There are a large number of dwelling-houses within a short distance of the well.

Chemical Examination of Water from the Wells of the Marblehead Water Company, Swampscott.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1887.												
174	June 21	June 23	None.	None.	0.00	23.12	–	–	.0002	.0020	2.59	.5200	–
411	July 27	July 27	None.	None.	0.00	23.90	–	–	.0009	.0030	2.95	.7800	–
608	Aug. 24	Aug. 25	None.	None.	0.00	24.50	–	–	.0007	.0025	2.82	.3750	–
831	Sept. 21	Sept. 22	None.	None.	0.00	24.20	–	–	.0006	.0038	2.89	.6500	–
1045	Oct. 26	Oct. 26	Distinct, milky.	None.	0.20	22.40	–	–	.0202	.0028	3.05	.3200	–
1093	Nov. 2	Nov. 3	None.	None.	0.00	24.95	–	–	.0000	.0018	3.05	.5000	–
1250	Nov. 22	Nov. 23	None.	None.	0.00	25.70	–	–	.0000	.0015	3.21	.7000	–
1260	Nov. 28	Nov. 29	None.	None.	0.00	24.80	–	–	.0002	.0028	3.35	.5000	–
1489	Dec. 27	Dec. 28	None.	None.	0.00	23.90	–	–	.0000	.0038	3.09	.5000	.0008

Chemical Examination of Water from the Wells of the Marblehead Water Company, Swampscott—Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
1677	Jan. 24	Jan. 25	None.	None.	0.00	24.10	–	–	.0001	.0014	3.04	.6750	.0001
1888	Feb. 23	Feb. 25	None.	None.	0.00	24.40	–	–	.0004	.0028	2.88	.5000	.0000
2091	Mar. 23	Mar. 24	Very slight.	Very slight.	0.00	22.60	–	–	.0008	.0056	2.93	.5000	.0002
2299	Apr. 24	Apr. 25	None.	None.	0.00	24.40	–	–	.0004	.0020	3.06	.4500	.0000
2501	May 23	May 24	None.	None.	0.00	25.30	–	–	.0000	.0020	2.94	.5000	.0001
2691	June 29	June 30	None.	None.	0.00	25.85	–	–	.0004	.0020	3.24	.5500	.0003
2859	Aug. 1	Aug. 1	None.	None.	0.00	25.40	–	–	.0000	.0012	3.07	.6500	.0020
3283	Sept. 27	Sept. 29	None.	None.	0.00	27.15	–	–	.0014	.0054	3.46	.4000	.0005
3459	Oct. 29	Oct. 29	None.	None.	0.00	26.10	–	–	.0002	.0022	3.18	.3500	.0003
3608	Nov. 27	Nov. 27	Distinct, milky.	Very slight.	0.00	25.15	–	–	.0038	.0108	4.76	.1800	.0003
3731	Dec. 17	Dec. 18	Sli't, milky.	None.	0.00	26.30	–	–	.0000	.0032	3.32	.1700	.0000
	1889.												
3917	Jan. 24	Jan. 24	None.	None.	0.00	24.40	–	–	.0000	.0018	3.33	.7500	.0002
4179	Mar. 1	Mar. 1	None.	None.	0.00	24.60	–	–	.0006	.0018	3.26	.5000	.0000
4434	Mar. 29	Mar. 29	Slight.	Slight.	0.00	27.20	–	–	.0000	.0064	5.02	.3250	.0001
4589	Apr. 27	Apr. 27	Sli't, milky.	None.	0.00	26.65	–	–	.0014	.0038	3.77	.3600	.0007
4735	May 23	May 24	None.	None.	0.00	28.15	–	–	.0008	.0026	3.64	.2600	.0002
Av.	....	....	....	....	–	25.01	–	–	.0013	.0032	3.28	.4786	.0003

Hardness in May, 1888, 13.3. Odor, none.——The samples were collected from a faucet in the pumping station while pumping, or from the well.

Microscopical Examination.

	1888. Mar.	Apr.	May.	June.	Aug.	Sept.	Oct.	Nov.	Dec.	1889. Jan.	Mar.	Mar.	Apr.	May.
1. Blue-green Algæ,	0.0	–	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	–	0.0	0.0	0.0
2. Other Algæ,	0.0	–	0.0	0.0	pr.	0.0	0.0	0.0	0.0	0.0	–	0.0	0.0	pr.
3. Fungi,	0.0	–	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	–	0.0	0.0	0.0
4. Animal Forms,	0.0	–	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	–	0.0	0.0	0.0

Groups and principal genera of organisms observed: 2, Palmellaceæ; Diatomaceæ.

Chemical Examination of Water from the Tank of the Marblehead Water Company, Swampscott.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
1046	Oct. 25	Oct. 26	Very slight.	Con.,e'rthy.	0.0	24.30	–	–	.0166	.0030	2.88	.5000	–
1094	Nov. 2	Nov. 3	Very slight.	None.	0.0	24.30	–	–	.0000	.0011	2.98	.5500	–
1251	Nov. 22	Nov. 23	Slight.	None.	0.0	24.80	–	–	.0020	.0020	3.11	.4500	–
1261	Nov. 28	Nov. 29	None.	None.	0.0	24.50	–	–	.0002	.0012	3.25	.6500	–
1490	Dec. 27	Dec. 28	None.	None.	0.0	25.30	–	–	.0000	.0036	3.05	.6000	.0002
	1888.												
1678	Jan. 24	Jan. 25	Very slight.	None.	0.0	25.30	–	–	.0002	.0018	3.06	.7000	.0001
1889	Feb. 23	Feb. 25	Sli't, milky.	None.	0.0	24.70	–	–	.0017	.0037	2.86	.6700	.0020
2092	Mar. 23	Mar. 24	Very slight, milky.	Slight.	0.0	24.50	–	–	.0031	.0048	3.32	.4000	.0004
2300	Apr. 24	Apr. 25	Sli't, milky.	None.	0.0	25.15	–	–	.0012	.0022	3.04	.4500	.0006
2502	May 23	May 24	Very slight.	None.	0.0	24.70	–	–	.0000	.0028	2.93	.5000	.0003
Av.	....	....	....	....	0.0	24.76	–	–	.0025	.0026	3.05	.5470	.0006

Hardness in May, 1888, 13.3. Odor, none.—— The samples were collected from a faucet in a dwelling-house near the tank just before beginning to pump.

Microscopical Examination.

	1888. March.	1888. April.	1888. May.
1. Blue-green Algæ, ...	0.0	0.0	0.0
2. Other Algæ, ...	0.0	pr.	0.0
3. Fungi, ...	0.0	0.0	0.0
4. Animal Forms, ...	0.0	0.0	0.0

Groups and principal genera of organisms observed : 2. Diatomaceæ.

Chemical Examination of Water from Stacy's Brook in Swampscott.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
1047	Oct. 25	Oct. 26	Decided.	H'vy,e'rthy and floc't.	0.60	30.70 27.10	3.90 3.70	26.80 23.40	.5300	.1600	5.09	.0200	–
1096	Nov. 2	Nov. 3	Very decided.	Con.,e'rthy and floc't.	2.50	27.80 22.50	3.50 2.50	24.30 20.00	.5020	.1780 .1360	3.88	.0500	–
1249	Nov. 22	Nov. 23	Very decided.	H'vy,e'rthy and floc't.	0.40	19.70	3.40	16.30	.1580	.0880 .0780	2.58	.1000	–
1259	Nov. 28	Nov. 29	Decided.	Con.,e'rthy and floc't.	0.40	17.30	2.90	14.40	.1840	.0480 .0320	2.42	.0600	–
1491	Dec. 27	Dec. 28	Decided.	H'vy,e'rthy and floc't.	0.50	14.10 11.70	2.60 2.40	11.50 9.30	.0840	.0480 .0260	1.72	.1500	.0200
	1888.												
1679	Jan. 24	Jan. 25	Decided.	Con.,e'rthy and floc't.	0.30	21.70 16.30	4.00 3.00	17.70 13.30	.1080	.6200 .0440	2.51	.2500	.0200
1890	Feb. 23	Feb. 25	Very decided.	Con.,e'rthy and floc't.	0.40	16.50	4.00	12.50	.0960	.0720 .0400	1.49	.0900	.0080
2095	Mar. 23	Mar. 24	Decided.	Heavy, brown.	0.50	10.50 9.10	2.30 1.80	8.20 7.30	.0740	.0340 .0280	1.13	.0600	.0066
2301	Apr. 24	Apr. 25	Decided.	Heavy, brown.	0.45	13.75	3.20	10.55	.0620	.0320 .0160	1.80	.4000	.0028
2500	May 23	May 24	Very decided.	Heavy, brown.	0.80	15.15	3.35	11.80	.0740	.0620 .0420	1.78	.0600	.0087
2692	June 29	June 30	Decided.	Heavy, brown.	0.50	15.60	2.55	13.05	.5380	.0780 .0580	2.69	.0350	.0034
2860	Aug. 1	Aug. 1	Very decided.	Heavy, brown.	1.00	27.45 21.75	5.40 3.60	22.05 18.15	.9860	.1830 .1500	3.86	.0150	.0080
3282	Sept. 27	Sept. 29	Distinct.	Con.,e'rthy and floc't.	0.60	12.05 11.05	3.20 2.90	8.85 8.15	.0530	.0490 .0330	1.28	.1400	.0067
3460	Oct. 29	Oct. 29	Distinct.	Sli't, floc't.	0.70	11.75	2.80	8.95	.0480	.0220 .0100	1.54	.0780	.0057
3629	Dec. 3	Dec. 3	Distinct.	Con.,e'rthy.	0.20	11.60 10.35	3.00 2.90	8.60 7.45	.0500	.0220 .0200	1.45	.2500	.0022
3732	Dec. 18	Dec. 18	Decided.	Con.,e'rthy.	0.45	9.45 6.65	2.65 1.85	6.80 4.80	.0360	.0270 .0170	0.32	.1000	.0012
	1889.												
3916	Jan. 24	Jan. 24	Distinct.	Con.,e'rthy.	0.20	12.55 12.05	2.65 3.00	9.90 9.05	.0840	.0560 .0480	1.85	.1800	.0053
4180	Mar. 1	Mar. 1	Decided.	Consid'ble.	0.30	15.10 14.10	3.15 2.75	11.95 11.35	.1720	.1380 .1070	2.47	.1100	.0100
4435	Mar. 29	Mar. 29	Decided.	Consid'ble.	0.30	11.40 10.75	2.75 2.50	8.65 8.25	.0480	.0210 .0130	1.45	.1250	.0015
4588	Apr. 27	Apr. 27	Decided.	H'vy,e'rthy and floc't.	0.90	13.40 9.90	3.55 3.05	9.85 6.85	.0960	.0560 .0400	1.12	.0800	.0036
4734	May 23	May 24	Distinct.	Heavy.	1.20	10.75	3.25	7.50	.0500	.0410 .0052	1.09	.0600	.0032
Av.	....	....	....	....	0.63	16.68	3.31	13.37	.1858	.0936	2.07	.1149	.0069

Hardness in May, 1888, 3.4. Odor, generally offensive.——The samples were collected from the brook near the well of the Marblehead Water Company. There were heavy rains just previous to the collection of Nos. 1890 and 2095.

Microscopical Examination.

	1888.						1889.				
	June.	Aug.	Sept.	Oct.	Dec.	Dec.	Jan.	Mar.	Mar.	Apr.	May.
1. Blue-green Algæ,	pr.	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
2. Other Algæ,	0.7	0.2	0.0	0.3	0.0	0.0	pr.	0.1	pr.	1.0	3.6
3. Fungi,	0.2	0.1	0.0	0.0	0.0	0.0	0.0	10.1	pr.	0.0	0.0
4. Animal Forms,	0.2	0.2	0.2	pr.	0.0	0.0	pr.	0.1	0.0	pr.	1.4

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Synedra*. 3. Schizomycetes, *Leptothrix*. 4. Protozoa, *Trachelomonas;* Annelida.

Water Supply of Taunton.

Description of Works. — Population in 1885, 23,674. The works are owned by the city and were built in 1876. The average daily consumption for 1888 was 751,882 gallons. Water is taken from the ground by means of an open filter-basin and a covered filter-gallery on the left bank of the Taunton River above the city, and, when the supply of ground water is insufficient, is taken from the river, either directly or after being filtered through a coarse filter. The filter-basin is 400 feet long and its bottom is 8 feet below low water in the river. The basin is 17 feet wide at the bottom, and the sides have a slope of two feet horizontally to one foot vertically. The filter-gallery extends from the upper end of the filter-basin parallel with the river, a distance of 863 feet. In section it is egg-shaped, and its dimensions are 5 feet 2 inches in height and 4 feet in width. It is built of brick with some of the joints uncemented, and its bottom is level with the bottom of the filter-basin. Two tubular wells were sunk in the bottom of this conduit at points where clay came close to the surface. The wells are respectively $1\frac{1}{4}$ and $1\frac{1}{2}$ inches in diameter and 25 and 37 feet deep. At the upper end of the filter-gallery a coarse filter, known as the "filter bank," has been built. It was formed by extending the conduit a distance of 94.6 feet and filling the space between it and the river with broken stone and gravel. The width of the filter between the conduit and the river is about 40 feet. Water is pumped directly into the mains and no reservoir or stand-pipe is used. Distributing mains are of cast iron. Service pipes are of wrought iron lined with cement. A disagreeable taste and odor in the water supplied to consumers has been noticed occasionally, and is thought to be due to growths of algæ in the open filter-basin.

Chemical Examination of Water from the Filter-Basin of the Taunton Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
177	June 22	June 23	Decided.	Consid'ble.	0.40	5.90	–	–	.0024	.0089	.55	.0190	–
391	July 22	July 23	Very slight.	None.	0.40	5.62	–	–	.0019	.0091	.58	.0260	–
606	Aug. 23	Aug. 24	Distinct.	Very slight.	0.40	5.52	–	–	.0009	.0145	.54	.0120	–
812	Sept. 19	Sept. 20	Sli't, milky.	Very slight.	0.20	5.90	–	–	.0020	.0111	.61	.0070	–
1019	Oct. 24	Oct. 25	Very slight.	Slight.	0.25	5.50	–	–	.0006	.0042	.62	.0180	–
1247	Nov. 21	Nov. 22	Very slight.	None.	0.20	5.70	–	–	.0024	.0108	.66	.0200	–
1475	Dec. 22	Dec. 22	Slight.	Very slight.	0.20	5.45	–	–	.0020	.0056	.63	.0150	–
	1888.												
1674	Jan. 24	Jan. 24	Very slight.	Very slight.	0.20	5.65	–	–	.0016	.0078	.54	.0250	.0001
1877	Feb. 21	Feb. 23	Decided.	Con., e'rthy.	0.40	6.05	–	–	.0004	.0172	.51	.0100	.0000
2089	Mar. 23	Mar. 23	Distinct.	Slight.	0.40	4.85	–	–	.0010	.0142	.53	.0080	.0000
2297	Apr. 24	Apr. 25	Slight.	Slight.	0.15	5.35	–	–	.0008	.0058	.60	.0200	.0001
2485	May 22	May 22	Slight.	None.	0.35	5.55	–	–	.0004	.0080	.53	.0180	.0001
2646	June 21	June 22	Very slight.	None.	0.70	5.40	–	–	.0016	.0124 .0104	.52	.0180	.0001
2853	July 26	July 27	None.	Very slight.	0.20	5.35	–	–	.0014	.0078 .0078	.57	.0190	.0001
3024	Aug. 23	Aug. 24	Very slight.	Very slight.	0.40	5.45	–	–	.0018	.0118 .0112	.53	.0050	.0001
3280	Sept. 27	Sept. 28	Distinct.	Slight.	1.30	5.40	–	–	.0006	.0290 .0260	.39	.0090	.0002
3454	Oct. 26	Oct. 27	Very slight.	Very slight.	0.40	5.65	–	–	.0010	.0072 .0070	.62	.0150	.0000
3607	Nov. 26	Nov. 27	Very slight.	Very slight.	0.50	5.30	–	–	.0008	.0084 .0080	.55	.0180	.0001
3772	Dec. 20	Dec. 21	Sli't, milky.	Very slight.	0.60	4.80 4.35	–	–	.0004	.0142 .0112	.51	.0150	.0002
	1889.												
3923	Jan. 24	Jan. 25	Distinct, milky.	None.	0.10	5.05	–	–	.0008	.0040	.57	.0300	.0000
4169	Feb. 28	Mar. 1	Very slight.	Sli't, e'rthy.	0.15	5.45	–	–	.0000	.0022	.63	.0220	.0000
4433	Mar. 29	Mar. 29	None.	Very slight.	0.10	5.10	–	–	.0014	.0044	.58	.0200	.0000
4592	Apr. 29	Apr. 30	Sli't, milky.	None.	0.60	4.75	–	–	.0004	.0158 .0116	.50	.0070	.0001
4730	May 23	May 24	Sli't, milky.	None.	0.70	5.25	–	–	.0010	.0100 .0088	.57	.0150	.0001
Av.	....	....	....	....	0.39	5.47	–	–	.0012	.0102	.56	.0163	.0001

Hardness in May, 1888, 1.9. Odor, frequently vegetable, occasionally none. —— The samples were collected from a faucet at the pumping station while pumping. There were heavy rains just previous to the collection of Nos. 606, 2089, 2646, 2853 and 3280.

Microscopical Examination.

	1888.							1889.				
	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ, ...	pr.	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	pr.	0.0	0.8
2. Other Algæ, ...	0.1	4.9	0.8	0.1	0.1	0.0	0.2	pr.	0.7	0.4	0.1	0.6
3. Fungi, ...	0.2	5.1	0.1	0.0	0.0	0.0	0.0	0.0	pr.	0.0	0.0	0.0
4. Animal Forms, ...	pr.	0.0	pr.	pr.	0.0	0.0	pr.	0.0	0.0	pr.	0.0	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ, *Scenedesmus;* Desmidiaceæ; Diatomaceæ, *Melosira;* Zygnemaceæ. 3. Schizomycetes, *Crenothrix.* 4. Protozoa; Spongiaria; Entomostraea.

Chemical Examination of Water from the Taunton River at Taunton.

[Parts per 100,000.]

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.	Chlorine.	Nitrates.	Nitrites.
	1887.												
176	June 22	June 23	None.	Slight.	1.20	4.97	1.85	3.12	.0034	.0322	.48	.0130	–
390	July 22	July 23	Slight.	Very slight.	1.10	5.20	1.55	3.65	.0030	.0265	.48	.0130	–
605	Aug. 23	Aug. 23	Very slight.	Sli't, rusty.	1.30	5.60	1.82	3.78	.0043	.0271	.52	.0070	–
813	Sept. 19	Sept. 20	None.	Slight.	1.50	5.85	1.70	4.15	.0047	.0302	.59	.0070	–
1018	Oct. 24	Oct. 25	Slight.	Sli't, earthy and floc't.	1.00	6.10	1.70	4.40	.0004	.0212	.72	.0080	–
1246	Nov. 21	Nov. 22	Slight.	Slight.	1.40	6.65	3.00	3.65	.0026	.0286	.73	.0100	–
1474	Dec. 22	Dec. 22	Distinct.	Consid'ble.	1.50	6.50	3.00	3.50	.0024	.0334	.58	.0100	–
	1888.												
1673	Jan. 24	Jan. 24	Very slight.	Very slight.	1.00	5.85	2.55	3.30	.0025	.0229	.50	.0200	.0000
1876	Feb. 21	Feb. 23	Decided.	Sli't, earthy and floc't.	0.70	6.35	2.35	4.00	.0020	.0290	.46	.0100	.0000
2088	Mar. 23	Mar. 23	Decided.	Con., earthy and floc't.	0.70	5.85	2.25	3.60	.0007	.0318	.44	.0060	.0000
2296	Apr. 24	Apr. 25	Slight.	Slight.	1.40	4.50	1.60	2.90	.0008	.0251	.50	.0090	.0001
2486	May 22	May 22	Very slight.	Slight.	2.50	5.45	2.80	2.65	.0016	.0350	.38	.0080	.0001
2645	June 21	June 22	Very slight.	Slight.	2.30	5.40	2.65	2.75	.0042	.0342 .0306	.45	.0080	.0002
2852	July 26	July 27	Very slight.	Very slight.	1.50	4.95	1.80	3.15	.0030	.0274 .0250	.50	.0050	.0001
3023	Aug. 23	Aug. 24	Slight.	Slight.	1.20	5.45	1.95	3.50	.0010	.0282 .0248	.42	.0030	.0002
3279	Sept. 27	Sept. 28	Decided.	M'ch, e'rthy and floc't.	1.80	5.20	2.60	2.60	.0014	.0420 .0320	.27	.0050	.0002
3453	Oct. 26	Oct. 27	Very slight.	Very slight.	2.30	5.90	3.15	2.75	.0000	.0298 .0286	.53	.0090	.0002
3606	Nov. 26	Nov. 27	Slight.	Con., earthy and floc't.	1.80	4.35	2.05	2.30	.0002	.0270 .0250	.42	.0100	.0003
3773	Dec. 20	Dec. 21	Distinct, milky.	Sli't, earthy.	0.90	3.70	1.55	2.15	.0002	.0200 .0190	.42	.0100	.0002

Chemical Examination of Water from the Taunton River at Taunton—Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
3922	Jan. 24	Jan. 25	Slight.	Very slight.	1.10	3.85	1.65	2.20	.0000	.0184 .0170	.41	.0070	.0002
4168	Feb. 28	Mar. 1	Very slight.	Very slight.	1.00	4.05	1.75	2.30	.0004	.0194 .0172	.46	.0070	.0001
4432	Mar. 29	Mar. 29	Slight.	Slight.	1.00	4.10	1.90	2.20	.0000	.0200 .0124	.49	.0050	.0002
4593	Apr. 29	Apr. 30	Distinct.	Consid'ble.	2.00	5.00	2.55	2.45	.0008	.0364 .0328	.44	.0060	.0001
4729	May 23	May 24	Very slight.	Slight.	2.70	5.50	3.00	2.50	.0048	.0346 .0308	.43	.0050	.0002
Av.	....	....	....	....	1.45	5.74	2.18	3.56	.0019	.0284	.49	.0084	.0001

Hardness in May, 1888, 1.0. Odor, vegetable, frequently mouldy.——The samples were collected from the river opposite the filter-basin of the Taunton Water Works.

Microscopical Examination.

	1888. June.	1888. July.	1888. Aug.	1888. Sept.	1888. Oct.	1888. Nov.	1888. Dec.	1889. Jan.	1889. Feb.	1889. Mar.	1889. Apr.	1889. May.
1. Blue-green Algæ, ...	pr.	0.0	0.0	0.3	pr.	0.0	0.0	0.0	0.0	0.0	0.0	pr.
2. Other Algæ, ...	0.1	1.6	0.6	2.7	0.0	0.2	0.3	0.3	5.6	5.3	0.3	0.3
3. Fungi, ...	0.1	2.5	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, ...	pr.	pr.	0.2	0.3	0.0	0.0	pr.	0.0	0.2	0.3	pr.	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Asterionella*, *Synedra*. 3. Sehizomyeetes, *Crenothrix*. 4. Protozoa; Spongiaria.

Chemical Examination of Water from Tubular Wells, Taunton.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
857	Sept. 27	Sept. 28	Very slight.	Very slight, earthy.	0.0	14.30	–	–	.0000	.0017	3.51	.0130	–

The sample was collected from two tubular test wells, 41 and 48 feet deep, near the filter-basin of the Taunton Water Works.

Water Supply of the State Almshouse, Tewksbury.

This is a supply to a public institution having a population of about 885 in June, 1887. The works were built in 1870. The average daily consumption in 1888 was about 90,000 gallons. The source of supply is a brook, from which water is diverted into a small pump well 8 feet in diameter and 8 feet deep. The drainage area is said to contain a considerable amount of swamp land covered with a heavy growth of wood. Pumps force the water from the pump well to an open iron tank and two distributing reservoirs. The tank is 30 feet in diameter and 40 feet in height. The reservoirs are each 160 feet long and 110 feet wide at the top, and 10 feet deep. The bottom of each is of clay and the slopes are paved. The capacity of each is about 1,200,000 gallons. Distributing mains are of cast iron; service pipes are of wrought iron.

Chemical Examination of Water from a Faucet at the State Almshouse, Tewksbury.

[Parts per 100,000.]

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.
	1887.												
219	June 29	June 30	Decided.	Very slight.	1.10	5.37	1.55	3.82	.0002	.0330	.19	.0130	–
447	July 29	July 30	Slight.	Slight.	0.50	5.05	1.02	4.03	.0339	.0213	.24	.0030	–
665	Aug. 31	Sept. 1	Slight.	Slight.	1.00	5.45	2.17	3.28	.0080	.0392	.18	.0070	–
837	Sept. 22	Sept. 22	Decided.	Consid'ble.	1.50	5.75	2.05	3.70	.0012	.0382	.22	.0030	–
1048	Oct. 26	Oct. 26	Distinct.	Con., green.	1.30	6.00	2.30	3.70	.0002	.0359	.30	.0080	–
1281	Nov. 30	Nov. 30	Slight.	Slight.	1.30	5.05	2.00	3.05	.0026	.0278	.33	.0070	–
1495	Dec. 28	Dec. 28	Very slight.	Slight.	1.30	4.90	1.70	3.20	.0004	.0220	.28	.0090	–
	1888.												
1700	Jan. 30	Jan. 31	Slight.	Very slight.	0.90	5.25	1.95	3.30	.0010	.0193	.21	.0100	.0000
1916	Feb. 29	Feb. 29	Slight.	None.	0.90	4.70	1.55	3.15	.0018	.0164	.29	.0100	.0000
2117	Mar. 27	Mar. 29	Very slight.	Very slight.	0.50	3.40	1.30	2.10	.0034	.0189	.24	.0050	.0001
2323	Apr. 27	Apr. 27	Slight.	Very slight.	0.45	2.60	1.05	1.55	.0050	.0135	.20	.0080	.0003
2685	June 28	June 29	Slight.	None.	2.10	6.25	2.90	3.35	.0030	.0342 .0318	.20	.0070	.0001
2857	July 30	July 31	Distinct.	Slight.	0.50	4.40	1.55	2.85	.0110	.0334 .0220	.22	.0070	.0001
3273	Sept. 27	Sept. 27	Distinct.	Slight.	0.50	4.65	1.75	2.90	.0004	.0250 .0186	.22	.0030	.0001
3462	Oct. 29	Oct. 30	Distinct.	Slight.	1.10	4.80	2.20	2.60	.0014	.0260 .0238	.25	.0020	.0002
3618	Nov. 27	Nov. 28	Slight.	Slight.	0.80	4.50	2.00	2.50	.0004	.0278 .0246	.26	.0070	.0002
3767	Dec. 19	Dec. 21	Distinct.	Sli't, green.	0.70	3.95	1.65	2.30	.0002	.0234 .0202	.23	.0040	.0002

Chemical Examination of Water from a Faucet at the State Almshouse — Con.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
3903	Jan. 23	Jan. 23	Decided.	Slight.	0.80	3.55	1.35	2.20	.0004	.0172 .0144	.23	.0090	.0001
4158	Feb. 27	Feb. 28	Slight.	Slight.	0.60	4.25	1.35	2.90	.0018	.0200 .0190	.29	.0050	.0003
4417	Mar. 27	Mar. 28	Very slight.	Very slight.	0.45	3.25	0.95	2.30	.0016	.0180 .0150	.20	.0030	.0001
4722	May 22	May 23	Distinct.	Con., light.	0.90	3.85	1.70	2.15	.0004	.0278 .0210	.22	.0020	.0002
Av.	....	....	....	....	0.91	4.87	1.69	3.18	.0022	.0256	.24	.0063	.0001

Odor, faintly vegetable.——The samples were collected from a faucet in the Almshouse, with the exception of No. 2685, which was collected from a faucet at the pumping station.

Microscopical Examination.

	1888. June.	1888. July.	1888. Sept.	1888. Oct.	1888. Nov.	1888. Dec.	1889. Jan.	1889. Feb.	1889. Mar.	1889. May.
1. Blue-green Algæ, ...	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	0.0	7.7	12.3	0.3	0.1	2.0	pr.	3.1	66.5	13.4
3. Fungi, ...	0.8	1.3	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, ...	0.0	pr.	0.0	pr.	0.0	0.1	pr.	30.1	1.0	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ, *Pediastrum*, *Raphidium*, *Scenedesmus*; Desmidiaceæ, *Cosmarium*; Diatomaceæ, *Melosira*, *Nitzchia*, *Stephanodiscus*, *Synedra*. 3. Schizomycetes, *Crenothrix*. 4. Protozoa, *Dinobryon*.

Chemical Examination of Water from a Well at the State Almshouse, Tewksbury.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
218	June 29	June 30	None.	None.	0.0	17.40	–	–	.0285	.0071	1.43	.1950	–
446	July 29	July 30	None.	None.	0.0	15.75	–	–	.0244	.0038	1.22	.6500	–
664	Aug. 31	Sept. 1	None.	Very slight.	0.0	15.77	–	–	.0615	.0070	1.11	.3900	–
	1888.												
2524	May 29	May 29	Very slight.	None.	0.0	16.85	–	–	.0014	.0050	1.63	.4500	.0005
	1889.												
4586	Apr. 26	Apr. 27	None.	None.	0.0	17.50	–	–	.0320	.0080	1.16	.4800	.0009
Av.	....	....	....	....	0.0	16.65	–	–	.0296	.0062	1.31	.4330	–

Hardness in May, 1888, 6.1. Odor, none.——The samples were collected from a well in the yard of the Almshouse. Water was drawn from the well by means of a wooden pump.

Microscopical Examination.

May, 1888; April, 1889. No organisms.

WATER SUPPLY OF TISBURY.—VINEYARD HAVEN WATER COMPANY.

Description of Works. — Population of the town of Tisbury in 1885, 1,541. The works are owned by the Vineyard Haven Water Company. Water was introduced Dec. 1, 1887. The source of supply is a spring near the northern shore of Lake Tashmoo. The water of the spring is collected by means of a filter-gallery 38 feet long, 7 feet wide at the bottom, and 10 feet high. Pumps force the water to an open iron tank 20 feet in diameter and 50 feet in height. The tank is situated between the pumping station and the village, and all water pumped passes through it. Distributing mains are of cast iron. Service pipes are of lead.

Chemical Examination of Water from the Tashmoo Spring at Vineyard Haven.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1887.												
89	June 13	June 14	None.	Very slight.	0.0	3.65	–	–	.0000	.0006	1.09	.0000	–
	1888.												
3165	Sept. 11	Sept. 13	None.	None.	0.0	4.00	–	–	.0000	.0010	0.93	.0050	.0000

Odor, none.—— Sample No. 89 was collected from the spring before the filter-gallery was constructed.

Microscopical Examination.

September, 1888. 1. Blue-green algæ, 0.0; 2. Other algæ, 0.1; 3. Fungi, 0.0; 4. Animal forms, 0.0. Groups and principal genera of organisms observed: 2. Palmellaceæ.

TYNGSBOROUGH.

Chemical Examination of Water from Tyng's Pond in Tyngsborough.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1889.												
4720	May 22	May 23	Very slight.	Sli't, white.	0.0	2.15	0.85	1.30	.0004	.0166 .0124	.16	.0020	.0001

Odor, faintly vegetable.—— The sample was collected from the pond 200 feet from shore.

Microscopical Examination.

1. Blue-green algæ, 1.0; 2. Other algæ, 1.2; 3. Fungi, 0.0; 4. Animal forms, pr.
Groups and principal genera of organisms observed: 1. Cyanophyceæ, *Anabæna*. 2. Zoosporeæ; Diatomaceæ. 4. Rotifera; Entomostraca.

Water Supply of Uxbridge. — Uxbridge Water Company.

Description of Works. — Population in 1885, 2,948. The works are owned by the Uxbridge Water Company, and were built in 1879. Water is supplied to the main village of Uxbridge. The sources of supply are springs, the water of which is collected by drains and stored in two small reservoirs. The drains were laid in three directions from a main drain 300 feet long running up the side of a hill. Two of the branch drains are each 100 feet in length and the third is 150 feet long. The larger reservoir is 80 feet long, 60 feet wide and 9 feet deep, with perpendicular walls and ledge bottom. The walls are laid up in cement to one foot above the surface of the ground and the reservoir is covered with a wooden roof. This reservoir was built in 1882. The smaller reservoir, built in 1879, is 25 feet in diameter and 15 feet in depth, and is constructed in the same manner as the larger one. Water is distributed by gravity. Distributing mains are of cast iron; service pipes are of wrought iron.

Chemical Examination of Water from a Faucet in Uxbridge, supplied from the Works of the Uxbridge Water Company.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
150	June 20	June 21	None.	None.	0.0	2.70	–	–	.0001	.0002	.18	.0000	–
151	June 20	June 21	None.	None.	0.0	2.55	–	–	.0000	.0001	.17	.0000	–
380	July 21	July 22	Sli't, milky.	None.	0.0	2.87	–	–	.0002	.0034	.19	.0260	–
570	Aug. 17	Aug. 18	None.	None.	0.0	2.95	–	–	.0000	.0000	.15	.0130	–
758	Sept. 14	Sept. 14	None.	None.	0.0	2.77	–	–	.0000	.0010	.18	.0130	–
1205	Nov. 16	Nov. 17	None.	None.	0.0	2.40	–	–	.0002	.0000	.17	.0080	–
	1888.												
1632	Jan. 19	Jan. 20	None.	None.	0.0	2.20	–	–	.0000	.0004	.16	.0180	–
2015	Mar. 15	Mar. 16	None.	None.	0.0	2.40	–	–	.0008	.0010	.15	.0080	.0000
2210	Apr. 13	Apr. 14	None.	None.	0.0	2.20	–	–	.0000	.0026	.17	.0200	.0001
2405	May 11	May 12	None.	None.	0.0	2.25	–	–	.0000	.0000	.16	.0120	.0000
Av.	....	....	....	....	0.0	2.53	–	–	.0001	.0009	.17	.0118	–

Hardness in May, 1888, 0.5. Odor, none. —— The samples were collected from a faucet in the village, with the exception of No. 150, which was collected from a pipe which conveys water to the larger reservoir from the springs.

Microscopical Examination.

March, April, May, 1888. No organisms.

WATER SUPPLY OF WAKEFIELD AND STONEHAM. — WAKEFIELD WATER COMPANY.

Description of Works. — Population in 1885: Wakefield, 6,060; Stoneham, 5,659; total, 11,719. The works are owned by the Wakefield Water Company, and were built in 1883. The average daily consumption in 1887 was about 325,000 gallons. The source of supply is Smith Pond or Crystal Lake in Wakefield. Its area is about 55 acres. At high water about 30 acres more are flowed to a slight depth. The maximum depth of the pond is 26 feet and its general depth is about 13 feet. The bottom is of gravel except at the southerly end where it is muddy. The drainage area, of about one square mile, is for the most part rocky pasture and woodland, though there is quite a large number of houses in the vicinity of the Boston and Maine Railroad. Pumps force the water from the pond to the distributing mains and to an open iron tank, 40 feet in diameter and 62 feet in height, located in Stoneham. Distributing mains are of wrought iron lined with cement; service pipes are of cast iron.

Chemical Examination of Water from Crystal Lake, Wakefield.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.		Nitrates.	Nitrites.
	1887.												
88	June 11	June 14	Slight.	None.	0.10	3.55	1.27	2.28	.0029	.0148	.58	.0070	-
315	July 12	July 13	Very slight.	None.	0.20	3.82	1.00	2.82	.0014	.0192	.46	.0070	-
623	Sept. 1	Sept. 2	None.	None.	-	3.60	0.62	2.98	.0000	.0182	.50	.0030	-
815	Sept. 20	Sept. 20	Very slight.	Very slight.	0.10	3.90	0.75	3.15	.0002	.0194	.49	.0030	-
968	Oct. 18	Oct. 18	Very slight.	Slight.	0.40	3.60	0.70	2.90	.0000	.0158	.50	.0030	-
1182	Nov. 14	Nov. 15	Slight.	Very slight.	0.10	3.65	0.80	2.85	.0000	.0170	.52	.0040	-
1381	Dec. 12	Dec. 12	Distinct.	Con., white.	0.15	4.00	1.20	2.80	.0000	.0172	.54	.0030	-
	1888.												
1676	Jan. 24	Jan. 25	Very slight.	Very slight.	0.10	3.90	1.15	2.75	.0007	.0159	.54	.0100	.0000
1805	Feb. 13	Feb. 13	Very slight.	Sli't, white.	0.20	3.95	1.00	2.95	.0033	.0155	.52	.0150	.0002
2085	Mar. 22	Mar. 22	Slight.	Slight.	0.10	3.80	0.80	3.00	.0018	.0150	.52	.0120	.0000
2177	Apr. 10	Apr. 11	Slight.	Very slight.	0.30	3.55	0.80	2.75	.0006	.0166	.44	.0120	.0001
2409	May 14	May 14	Slight.	Very slight, white.	0.10	3.40	0.90	2.50	.0008	.0168	.43	.0090	.0001
2881	Aug. 3	Aug. 3	Distinct.	Very slight, white.	0.10	 **3.95**	 **0.90**	 **3.05**	.0000	.0192 **.0176**	.49	.0000	.0002

Chemical Examination of Water from Crystal Lake, Wakefield — Concluded.

Number.	Date of Collection.	Date of Exam-ination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albu-minoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
3029	Aug. 24	Aug. 25	Very slight.	Very slight.	0.10	3.65	1.00	2.65	.0002	.0170 .0158	.45	.0020	.0000
3251	Sept. 25	Sept. 25	None.	None.	0.05	3.45	0.80	2.65	.0008	.0174 .0164	.47	.0070	.0000
3434	Oct. 24	Oct. 24	Very slight.	Slight.	0.15	3.60	0.95	2.65	.0002	.0170 .0156	.47	.0050	.0001
	1889.												
3854	Jan. 16	Jan. 16	Sli't, milky.	Slight.	0.10	3.45	0.55	2.90	.0012	.0152 .0108	.49	.0200	.0004
4308	Mar. 14	Mar. 15	Distinct.	Consid'ble.	0.10	4.00	1.15	2.85	.0004	.0106 .0094	.49	.0220	.0002
4788	June 6	June 6	Slight.	Very slight.	0.10	3.35	0.90	2.45	.0010	.0166 .0154	.49	.0070	.0000
Av.	....	....	....	....	0.14	3.73	0.92	2.81	.0008	.0165	.49	.0079	.0001

Hardness in May, 1888, 1.7. Odor, faintly vegetable.—— The samples were collected from a faucet at the pumping station while pumping, with the exception of Nos. 88 and 2881 which were collected from the pond at the inlet to the water works.

Microscopical Examination.

	1888. Aug.	1888. Aug.	1888. Sept.	1888. Oct.	1889. Jan.	1889. Mar.	1889. June.
1. Blue-green Algæ, ...	pr.	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	5.9	0.7	2.6	3.2	4.6	20.1	pr.
3. Fungi, ...	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, ...	0.1	0.1	pr.	0.0	pr.	0.1	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; *Chlorococcus;* Zoosporeæ; Diatomaceæ, *Asterionella*, *Stephanodiscus*, *Tabellaria;* Volvocineæ. 4. Protozoa; Rotifera; Entomostraca.

Chemical Examination of Water from Lake Quannapowitt, Wakefield.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Exam-ination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albu-minoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
4103	Feb. 23	Feb. 25	Slight.	Slight.	0.6	7.10	2.10	5.00	.0000	.0266 .0180	.79	.0280	.0005

Hardness, 2.8. Odor, faintly vegetable.—— The sample was collected from the lake.

WATER SUPPLY OF WALTHAM.

Description of Works. — Population in 1885, 14,609. The works are owned by the city and were built in 1873. The average daily consumption in 1888 was 534,000 gallons. The source of supply is an open filter-basin on the left bank of Charles River above the city. The basin is irregular in shape, and has an area of about one-fourth of an acre. The bottom in the middle is 8.5 feet below the average level of the water in the river. The walls of the basin are of rough stone laid dry. In 1886 a direct connection was laid between the river and the basin, but it has never been used. Pumps force the water from the basin to an open distributing reservoir, which is oval in shape; the longer diameter measured on the bottom is 260 feet and the shorter one 210 feet. The depth of water when full is 15 feet and the area of the water surface about 62,000 square feet. Its capacity is a little over 6,000,000 gallons. The bottom is of clay, and the slopes are paved with granite blocks. Water enters the reservoir at one side and is drawn out at the other; and, as a rule, all water pumped passes through the reservoir. Distributing mains were originally of wrought iron lined with cement, but cast iron is now used for extensions. Service pipes are of wrought iron lined with cement. A vegetable growth occurs in the bottom of the filter-basin during the summer months.

Chemical Examination of Water from Filter-Basin of the Waltham Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
61	June 9	June 10	-	-	0.00	7.10	-	-	.0002	.0078	.44	.0260	-
261	July 6	July 7	Very slight.	None.	0.00	7.12	-	-	.0012	.0035	.54	.0260	-
503	Aug. 8	Aug. 9	None.	None.	0.00	6.82	-	-	.0008	.0034	.46	.0260	-
717	Sept. 8	Sept. 9	Slight.	Slight.	0.00	6.40	-	-	.0012	.0048	.49	.0260	-
918	Oct. 10	Oct. 11	None.	None.	0.00	6.55	-	-	.0000	.0022	.43	.0260	-
1129	Nov. 8	Nov. 9	Very slight.	Con. e'rthy.	0.00	6.60	-	-	.0004	.0024	.47	.0200	-
1351	Dec. 8	Dec. 8	Very slight.	Slight.	0.00	6.35	-	-	.0008	.0026	.48	.0250	-
	1888.												
1561	Jan. 9	Jan. 10	None.	Very slight.	0.00	6.70	-	-	.0000	.0027	.47	.0350	.0001
1770	Feb. 7	Feb. 8	Very slight.	None.	0.00	6.85	-	-	.0000	.0030	.47	.0230	.0005

Chemical Examination of Water from Filter-Basin of the Waltham Water Works — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
1975	Mar. 7	Mar. 8	None.	Slight.	0.00	6.80	–	–	.0002	.0074	.43	.0250	.0004
2196	Apr. 11	Apr. 12	Very slight.	Slight.	0.00	6.40	–	–	.0000	.0036	.46	.0300	.0004
2381	May 8	May 9	Very slight.	Very slight.	0.00	6.70	–	–	.0000	.0060	.47	.0250	.0005
2594	June 12	June 13	None.	None.	0.00	6.55	–	–	.0000	.0062 .0030	.48	.0500	.0002
2729	July 5	July 6	Very slight.	None.	0.00	6.95	–	–	.0004	.0058 .0050	.47	.0350	.0002
2905	Aug. 10	Aug. 10	None.	None.	0.00	7.00	–	–	.0036	.0056	.47	.0200	.0001
3216	Sept. 18	Sept. 19	Very slight.	Very slight.	0.00	7.30	–	–	.0016	.0080 .0040	.45	.0120	.0003
3365	Oct. 12	Oct. 13	Slight.	Sli't green.	0.00	6.20	–	–	.0002	.0080 .0046	.44	.0200	.0001
3518	Nov. 9	Nov. 10	Very slight.	Very slight.	0.05	6.65	–	–	.0022	.0044	.48	.0250	.0003
3672	Dec. 7	Dec. 8	None.	Slight.	0.00	6.30	–	–	.0024	.0044	.46	.0280	.0004
	1889.												
3939	Jan. 26	Jan. 28	None.	Very slight.	0.00	6.25	–	–	.0016	.0032	.47	.0400	.0004
4002	Feb. 8	Feb. 9	None.	None.	0.00	6.35	–	–	.0002	.0018	.51	.0500	.0001
4095	Feb. 22	Feb. 23	None.	Very slight.	0.00	6.45	–	–	.0000	.0034	.47	.0420	.0002
4258	Mar. 8	Mar. 9	Very slight.	None.	0.00	6.60	–	–	.0000	.0032	.50	.0400	.0001
4508	Apr. 12	Apr. 13	Very slight.	None.	0.03	6.45	–	–	.0000	.0052	.47	.0200	.0003
4645	May 10	May 11	None.	Sli't, e'rthy.	0.00	6.50	–	–	.0018	.0036	.45	.0350	.0001
Av.	....	....	....	....	0.00	6.62	–	–	.0008	.0045	.47	.0292	.0003

Hardness in May, 1888, 3.3; in May, 1889, 3.2. Odor, generally disagreeable. —— The samples were collected from the filter-basin.

Microscopical Examination.

	1888. June.	1888. July.	1888. Aug.	1888. Sept.	1888. Oct.	1888. Nov.	1888. Dec.	1889. Jan.	1889. Feb.	1889. Feb.	1889. Mar.	1889. Apr.	1889. May.
1. Blue-green Algæ, . .	0.0	0.0	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, . . .	8.1	1.0	1.3	21.0	3.6	1.2	pr.	pr.	pr.	0.2	0.2	1.1	0.1
3. Fungi, ...	0.1	0.0	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, . .	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ, *Chlorococcus;* Zoosporeæ, *Raphidium*, *Scenedesmus;* Desmidiaceæ; Diatomaceæ; Zygnemaceæ.

Chemical Examination of Water from the Distributing Reservoir of the Waltham Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Exam-ination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albu-minoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
63	June 9	June 10	–	–	0.0	6.22	–	–	.0007	.0055	.34	.0130	–
262	July 6	July 7	Very slight.	Slight.	0.0	6.70	–	–	.0010	.0051	.54	.0260	–
502	Aug. 8	Aug. 9	Very slight.	Very slight.	0.0	7.65	–	–	.0022	.0116	.53	.0260	–
718	Sept. 8	Sept. 9	Slight.	Very slight.	0.0	6.47	–	–	.0005	.0056	.47	.0130	–
919	Oct. 10	Oct. 11	None.	None.	0.0	6.45	–	–	.0000	.0042	.43	.0260	–
1130	Nov. 8	Nov. 9	Very slight.	Very slight.	0.0	6.60	–	–	.0000	.0042	.46	.0140	–
1352	Dec. 8	Dec. 8	Very slight.	Very slight.	0.0	6.55	–	–	.0002	.0066	.48	.0200	–
	1888.												
1562	Jan. 9	Jan. 10	Slight.	Very slight.	0.0	6.40	–	–	.0000	.0068	.47	.0280	.0000
1771	Feb. 7	Feb. 8	Slight.	Slight.	0.0	6.60	–	–	.0000	.0078	.47	.0200	.0005
1974	Mar. 7	Mar. 8	Distinct.	Slight.	0.0	6.50	–	–	.0004	.0088	.45	.0200	.0002
2197	Apr. 11	Apr. 12	Distinct.	Very slight.	0.0	6.40	–	–	.0000	.0061	.47	.0250	.0003
2382	May 8	May 9	Distinct.	None.	0.0	6.25	–	–	.0002	.0078	.48	.0250	.0002
2595	June 12	June 13	Slight.	Sli't, white.	0.0	**6.25**	–	–	.0000	.0080 **.0042**	.46	.0200	.0003
2730	July 5	July 6	Very slight.	Very slight.	0.0	**6.90**	–	–	.0000	.0054 **.0042**	.47	.0330	.0003
2906	Aug. 10	Aug. 10	Slight.	Very slight.	0.0	6.85 **6.80**	–	–	.0010	.0092 **.0060**	.49	.0220	.0002
3215	Sept. 18	Sept. 19	Very slight.	Very slight, white.	0.0	**6.25**	–	–	.0004	.0096 **.0064**	.42	.0220	.0002
3364	Oct. 12	Oct. 13	Very slight.	None.	0.0	**6.50**	–	–	.0004	.0048 **.0024**	.46	.0330	.0002
3519	Nov. 9	Nov. 10	Very slight.	Sli't, green.	0.0	6.30 **6.25**	–	–	.0006	.0086 **.0046**	.48	.0250	.0002
3673	Dec. 7	Dec. 8	Very slight.	Consid'ble.	0.0	6.15 **6.15**	–	–	.0000	.0070 **.0038**	.45	.0250	.0007
	1889.												
3940	Jan. 26	Jan. 28	Slight.	Con., light green.	0.0	6.25 **5.75**	–	–	.0006	0088 **.0044**	.47	.0300	.0002
4003	Feb. 8	Feb. 9	Distinct.	Con., light green.	0.0	6.40 **6.00**	–	–	.0000	.0080 **.0034**	.46	.0250	.0002
4096	Feb. 22	Feb. 23	Slight.	Heavy, green.	0.0	6.10 **5.85**	–	–	.0000	.0066 **.0028**	.47	.0400	.0005
4259	Mar. 8	Mar. 9	Very slight.	Slight.	0.0	6.20 **6.10**	–	–	.0000	.0076 **.0034**	.47	.0300	.0003
4509	Apr. 12	Apr. 13	Slight.	Con., green.	0.0	6.20	–	–	.0000	.0098 **.0040**	.46	.0180	.0003
4646	May 10	May 11	Very slight.	Con., light green.	0.0	6.10	–	–	.0010	.0062 **.0048**	.46	.0250	.0003
Av.	....	....	....	....	0.0	6.44	–	–	.0004	.0072	.46	.0242	.0003

Hardness in May, 1888, 3.1; in May, 1889, 2.9. Odor, generally none, occasionally disagreeable.—The samples were collected from the reservoir.

Microscopical Examination.

	1888.							1889.					
	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ, . .	0.0	0.0	0.0	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	3.5	9.0	21.0	2.0	2.2	8.3	15.0	19.3	75.0	1250.2	1100.1	88.1	9.0
3. Fungi, ...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, . .	pr.	pr.	pr.	pr.	0.0	0.0	0.0	5.6	0.3	4.2	50.0	2.2	0.5

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ, *Chlorococcus*, *Protococcus*; Zoosporeæ, *Scenedesmus*; Desmidiaceæ; Diatomaceæ, *Asterionella*, *Staurogenia*, *Stephanodiscus*, *Synedra*; Zygnemaceæ. 4. Protozoa, *Trachelomonas*.

Of the organisms present in February and March, 1889, *Asterionella* and *Synedra* were the most abundant.

Chemical Examination of Water from Faucets in Waltham, supplied from the Waltham Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
2198	Apr. 11	Apr. 12	None.	None.	0.05	6.65	–	–	.0000	.0026	.46	.0250	.0000
	1889.												
4647	May 10	May 11	Very slight.	Con., white.	0.00	6.25	–	–	.0000	.0060	.47	.0450	.0000

Hardness in May, 1889, 2.9.—— The samples were collected from faucets in the city.

Microscopical Examination.

April, 1888. 1. Blue-green algæ, 0.0; 2. Other algæ, pr.; 3. Fungi, 0.0; 4. Animal forms, pr.
May, 1889. 1. Blue-green algæ, 0.0; 2. Other algæ, 170.0; 3. Fungi, 0.0; 4. Animal forms, 151.0.

Groups and principal genera of organisms observed: 2. Zoosporeæ; Diatomaceæ, *Asterionella*, *Synedra*. 4. Protozoa, *Dinobryon*, *Trachelomonas*.

Chemical Examination of Water from Charles River at Waltham.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
62	June 9	June 10	–	–	1.20	6.07	2.32	3.75	.0044	.0440	.40	.0000	–
260	July 6	July 7	Very slight.	None.	0.60	5.50	1.80	3.70	.0034	.0249	.40	.0000	–
501	Aug. 8	Aug. 9	Slight.	Con., brown.	0.70	6.20	1.37	4.83	.0052	.0270	.38	.0030	–

Chemical Examination of Water from Charles River at Waltham — Concluded.

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.
	1887.												
716	Sept. 8	Sept. 9	Slight.	Con., brown.	0.55	6.27	1.40	4.87	.0027	.0271	.50	.0070	–
917	Oct. 10	Oct. 11	Slight.	Very slight.	0.50	5.90	1.10	4.80	.0010	.0241	.57	.0070	–
1128	Nov. 8	Nov. 9	Decided.	Slight.	0.50	6.20	1.75	4.45	.0010	.0192	.66	.0090	–
1350	Dec. 8	Dec. 8	Distinct.	Very slight.	0.50	6.85	2.10	4.75	.0026	.0272	.66	.0200	–
	1888.												
1563	Jan. 9	Jan. 10	Slight.	Very slight.	0.90	5.10	1.95	3.15	.0006	.0271	.35	.0200	.0000
1769	Feb. 7	Feb. 8	Slight.	Very slight, white.	0.60	6.20	1.90	4.30	.0063	.0289	.40	.0270	.0001
1973	Mar. 7	Mar. 8	Slight.	Sli't, earthy.	0.60	4.60	1.70	2.90	.0013	.0251	.32	.0120	.0000
2195	Apr. 11	Apr. 12	Distinct.	Sli't, white.	0.90	4.05	1.40	2.65	.0000	.0250	.28	.0070	.0001
2380	May 8	May 9	Distinct.	Very slight.	0.90	4.50	1.55	2.95	.0026	.0284	.39	.0080	.0001
2593	June 12	June 13	Slight.	Slight.	1.00	5.60	2.00	3.60	.0032	.0366 .0332	.30	.0120	.0002
2728	July 5	July 6	Slight.	Slight.	0.40	5.30	1.75	3.55	.0040	.0324 .0240	.40	.0070	.0001
2904	Aug. 10	Aug. 10	Slight.	Sli't, brown.	0.30	5.30	1.00	4.30	.0040	.0248 .0196	.46	.0030	.0001
3214	Sept. 18	Sept. 19	Very slight.	Very slight.	0.55	5.70	1.60	4.10	.0034	.0316 .0240	.44	.0030	.0003
3363	Oct. 12	Oct. 13	Distinct.	Very slight.	1.40	5.50	2.45	3.05	.0026	.0328 .0320	.38	.0120	.0003
3517	Nov. 9	Nov. 10	Very slight.	Slight.	1.30	5.40	2.50	2.90	.0038	.0276 .0262	.47	.0150	.0004
3671	Dec. 7	Dec. 8	None.	Very slight.	0.50	3.90	1.40	2.50	.0002	.0178 .0156	.37	.0100	.0005
	1889.												
3938	Jan. 26	Jan. 28	Very slight.	Very slight.	0.35	3.85	1.05	2.80	.0008	.0164 .0142	.34	.0150	.0002
4001	Feb. 12	Feb. 13	Very slight.	Sli't, earthy and floc't.	0.45	4.25	1.20	3.05	.0004	.0174 .0146	.40	.0200	.0002
4094	Feb. 22	Feb. 23	Slight.	Slight.	0.50	4.40	1.10	3.30	.0000	.0182 –	.36	.0200	.0005
4257	Mar. 8	Mar. 9	Very slight.	Very slight.	0.30	4.00	1.05	2.95	.0004	.0202 .0172	.37	.0100	.0004
4507	Apr. 12	Apr. 13	Very slight.	Slight.	0.60	4.15	1.55	2.60	.0000	.0250 .0222	.36	.0060	.0002
4644	May 10	May 11	Slight.	Con., earthy and floc't.	1.10	4.85	2.25	2.60	.0060	.0346 .0290	.38	.0070	.0003
Av.	....	....	....	....	0.69	5.62	1.70	3.92	.0024	.0265	.41	.0104	.0002

Hardness in May, 1888, 1.9. Odor, faintly vegetable, occasionally mouldy.——The samples were collected from the river near the filter-basin of the Waltham Water Works.

Microscopical Examination.

	1888.							1889.					
	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ,	0.0	0.0	0.0	pr.	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ,	0.5	4.3	1.1	0.4	0.2	1.8	0.2	0.2	1.7	1.2	1.5	1.6	0.7
3. Fungi,	2.5	0.3	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	pr.	0.0	0.0
4. Animal Forms,	3.2	11.5	0.3	0.3	pr.	0.0	pr.	pr.	1.0	pr.	0.3	0.3	60.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Melosira, Synedra;* Zygnemaceæ. 3. Schizomycetes, *Leptothrix.* 4. Protozoa, *Dinobryon*; Rotifera.

Water Supply of Ware.

Description of Works. — Population in 1885, 6,003. The works are owned by the town. Water was introduced in December, 1886. The average daily consumption in 1888 was 133,400 gallons. The source of supply is a large covered well on the left bank of Muddy Brook, a short distance above its confluence with the Ware River. The well is 26 feet in diameter and 22 feet deep, built of brick laid in cement. Pumps force the water from the well to an open distributing reservoir situated on the opposite side of the town from the well. The reservoir is rectangular in shape, 154.5 feet long and 97.5 feet wide at the top. It is 15 feet deep when full, and contains 1,558,000 gallons. The bottom is covered with a layer of concrete six inches in thickness and the slopes are paved with stone. Beneath the stone paving a layer of concrete 10 inches in thickness extends from the bottom up the slope to a level eight feet below the top of the embankment. Distributing mains are of cast iron; service pipes are of wrought iron lined with cement.

Chemical Examination of Water from the Well of the Ware Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.	1887.											
180	June 22	June 24	None.	None.	0.0	6.07	–	–	.0000	.0001	0.38	.2340	–
425	July 26	July 28	Very slight.	None.	0.0	7.35	–	–	.0005	.0010	0.51	.2200	–
635	Aug. 26	Aug. 29	None.	None.	0.0	7.65	–	–	.0000	.0008	0.48	.1560	–
861	Sept. 29	Oct. 1	None.	None.	0.0	7.50	–	–	.0000	.0008	0.52	.3380	–

Chemical Examination of Water from the Well of the Ware Water Works — Con.

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.		Nitrates.	Nitrites.
	1887.												
1085	Nov. 1	Nov. 2	None.	None.	0.0	7.10	–	–	.0000	.0022	0.56	.3000	–
1271	Nov. 29	Nov. 30	None.	None.	0.0	6.65	–	–	.0004	.0018	0.53	.3500	–
	1888.												
1541	Jan. 3	Jan. 6	None.	None.	0.0	6.45	–	–	.0000	.0016	0.50	.1100	.0001
1696	Jan. 24	Jan. 26	None.	None.	0.0	6.55	–	–	.0000	.0008	0.48	.2200	.0004
1883	Feb. 21	Feb. 23	Distinct.	Sli't, e'rthy.	0.0	7.60	–	–	.0002	.0030	0.50	.2750	.0001
2074	Mar. 20	Mar. 22	Very slight.	None.	0.1	6.80	–	–	.0000	.0012	0.52	.3250	.0003
2271	Apr. 17	Apr. 21	None.	None.	0.0	5.90	–	–	.0000	.0018	0.46	.2500	.0002
2468	May 18	May 19	None.	None.	0.0	7.20	–	–	.0000	.0006	0.52	.3250	.0005
2683	June 25	June 28	None.	None.	0.0	8.15	–	–	.0000	.0014	0.64	.4250	.0001
2851	July 24	July 26	None.	None.	0.0	8.35	–	–	.0000	.0014	0.69	.3500	.0002
3025	Aug. 23	Aug. 24	None.	None.	0.0	8.60	–	–	.0000	.0008	0.70	.3000	.0002
3234	Sept. 20	Sept. 21	None.	None.	0.0	9.10	–	–	.0000	.0004	0.68	.4000	.0003
3377	Oct. 16	Oct. 17	Very slight.	None.	0.0	7.80	–	–	.0000	.0000	0.70	.5200	.0002
3616	Nov. 27	Nov. 28	None.	None.	0.0	7.60	–	–	.0000	.0004	9.70	.3000	.0001
3725	Dec. 14	Dec. 15	None.	None.	0.0	7.30	–	–	.0000	.0004	0.69	.2800	.0001
	1889.												
3867	Jan. 17	Jan. 19	None.	None.	0.0	7.25	–	–	.0000	.0004	0.67	.3000	.0000
4255	Mar. 8	Mar. 9	None.	None.	0.0	7.45	–	–	.0000	.0028	0.79	.1500	.0001
4436	Mar. 28	Mar. 30	None.	None.	0.0	7.70	–	–	.0000	.0010	0.81	.4400	.0000
4548	Apr. 19	Apr. 22	None.	None.	0.0	8.75	–	–	.0000	.0008	0.96	.3100	.0001
4681	May 16	May 17	None.	None.	0.0	9.25	–	–	.0000	.0008	1.05	.3000	.0000
Av.	....	....	....	....	0.0	7.51	–	–	.0000	.0011	.63	.2991	.0002

Hardness in May, 1888, 2.5. Odor, none.——The samples were collected from a faucet at the pumping station while pumping. Subsequent analyses do not show any further increase in the amount of chlorine or nitrates.

Microscopical Examination.

	1888.							1889.				
	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Mar.	Mar.	Apr.	May.
1. Blue-green Algæ, ...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	pr.	0.0	pr.	0.0	0.0	0.0	0.0	pr.	pr.	0.0	0.0	0.0
3. Fungi, ...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, ...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Groups and principal genera of organisms observed: 2. Zoosporeæ; Diatomaceæ.

Chemical Examination of Water from the Distributing Reservoir of the Ware Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
181	June 22	June 24	Slight.	Slight.	0.00	6.77	–	–	.0001	.0010	.37	.2080	–
424	July 28	July 28	Slight.	None.	0.10	7.42	–	–	.0068	.0183	.43	.2000	–
634	Aug. 27	Aug. 29	Decided.	None.	0.20	7.05	–	–	.0030	.0285	.43	.1560	–
860	Sept. 30	Oct. 1	Distinct.	Very slight.	0.00	7.60	–	–	.0010	.0209 .0070	.47	.2080	–
1086	Nov. 1	Nov. 2	Slight.	Very slight, white.	0.00	7.35	–	–	.0000	.0096	.55	.2500	–
1270	Nov. 28	Nov. 30	Slight.	Slight.	0.00	7.20	–	–	.0004	.0054	.53	.3400	–
	1888.												
1540	Jan. 3	Jan. 6	Slight.	Slight.	0.00	6.00	–	–	.0004	.0068	.45	.2200	.0020
1704	Jan. 30	Jan. 31	Slight.	Sli't, brown.	0.10	7.50	–	–	.0000	.0028	.44	.3000	.0008
1884	Feb. 21	Feb. 23	Slight.	Sli't, brown.	0.05	7.15	–	–	.0000	.0046	.52	.2600	.0006
2075	Mar. 20	Mar. 22	Distinct.	None.	0.00	6.80	–	–	.0008	.0070	.49	.2250	.0009
2272	Apr. 17	Apr. 21	Distinct.	Slight.	0.00	6.55	–	–	.0028	.0160	.45	.2500	.0012
2467	May 18	May 19	Slight.	Very slight.	0.05	6.75	–	–	.0018	.0162	.44	.1250	.0018
2682	June 25	June 28	Very slight.	Slight.	0.05	6.75	–	–	.0046	.0132 .0066	.52	.2250	.0024
2850	July 24	July 26	Slight.	Sli't, green.	0.00	7.75 7.20	–	–	.0018	.0098 .0036	.56	.3000	.0019
3026	Aug. 23	Aug. 24	Very slight.	Very slight	0.00	8.35 8.30	–	–	.0022	.0082 .0060	.57	.2200	.0022
3235	Sept. 20	Sept. 21	Very slight.	Very slight.	0.00	8.75 8.45	–	–	.0024	.0070 .0050	.62	.3500	.0028
3378	Oct. 16	Oct. 17	Very slight.	Sli't, white	0.00	8.15 8.00	–	–	.0010	.0126 .0098	.68	.3600	.0013
3617	Nov. 26	Nov. 28	None.	Slight.	0.00	8.25 8.10	–	–	.0032	.0036 .0014	.70	.3000	.0006
3726	Dec. 13	Dec. 15	Slight.	Con., white.	0.00	8.25 7.60	–	–	.0000	.0030 .0022	.70	.3200	.0006
	1889.												
3868	Jan. 16	Jan. 19	Slight.	Slight.	0.00	7.45 7.35	–	–	.0008	.0054 .0028	.68	.2750	.0005
4256	Mar. 8	Mar. 9	None.	Very slight.	0.00	7.05	–	–	.0000	.0044	.72	.2800	.0007
4437	Mar. 28	Mar. 30	Very slight.	Very slight.	0.00	7.90	–	–	.0004	.0058 .0042	.77	.4000	.0010
4549	Apr. 19	Apr. 22	Very slight.	Very slight.	0.00	8.85	–	–	.0006	.0066 .0026	.81	.3000	.0017
4682	May 16	May 17	Very slight.	Very slight.	0.00	9.30	–	–	.0020	.0092 .0050	.90	.3000	.0034
Av.	....	....	....	....	0.02	7.57	–	–	.0015	.0094	.58	.2597	.0015

Hardness in February, 1888, 2 6; in May, 1888, 2.6. Odor, generally none, rarely disagreeable.—— The samples were collected from the reservoir or from the first tap on the main pipe leading from the the reservoir. The reservoir was drawn off and cleaned May 2, 1889.

Microscopical Examination.

	1888.							1889.				
	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Mar.	Mar.	Apr.	May.
1. Blue-green Algæ,	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ,	152.5	502.1	20.4	0.4	0.0	0.0	0.1	0.0	0.0	0.1	0.0	pr.
3. Fungi,	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms,	0.2	8.0	0.6	0.1	0.0	pr.	pr.	0.0	0.6	0.0	0.0	pr.

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ, *Raphidium*, *Scenedesmus;* Desmidiaceæ; Diatomaceæ, *Synedra*. 3. Schizomycetes. 4. Protozoa, *Peridinium;* Rotifera; Entomostraca. Nearly all of the organisms present in June and July, 1888, were *Synedra*.

Chemical Examination of Water from a Faucet in Ware, supplied from the Ware Water Works.

[Parts per 100,000.]

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.
	1888.												
1695	Jan. 24	Jan. 26	None.	None.	0.0	7.05	–	–	.0000	.0020	.51	.2800	.0004

Chemical Examination of Water from Muddy Brook at Ware.

[Parts per 100,000.]

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.
	1887.												
1084	Nov. 1	Nov. 2	Very slight.	Slight.	0.7	4.35	1.25	3.10	.0004	.0210	.15	.0030	–

Odor, vegetable.—— The sample was collected from the brook near the well of the Ware Water Works.

Water Supply of Warren.

Description of Works. — Population in 1885, 4,032. The town is supplied by several small aqueduct companies from springs in the hills about the town, from which the water flows by gravity. The Warren Aqueduct Company, which is one of the largest companies, supplied about 23 families in 1887. The water supplied by this company is obtained from three wells on the side of a hill near the town.

Two of the wells are long and narrow and about 14 feet deep. The third is about $2\frac{1}{2}$ feet in diameter and 20 feet deep. Water is distributed through lead pipes, the largest main being about 2 inches in diameter.

Chemical Examination of Water from a Faucet in Warren supplied from the pipes of the Warren Aqueduct Company.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
124	June 16	June 17	None.	None.	0.0	4.35	–	–	.0000	.0024	.13	.0330	–
362	July 19	July 20	None.	None.	0.0	4.57	–	–	.0000	.0011	.14	.0030	–
545	Aug. 15	Aug. 16	None.	None.	0.0	4.75	–	–	.0001	.0002	.14	.0200	–
	1888.												
1581	Jan. 11	Jan. 12	None.	None.	0.0	3.65	–	–	.0000	.0005	.12	.0400	.0002
2222	Apr. 16	Apr. 17	None.	None.	0.0	3.20	–	–	.0000	.0014	.13	.0250	.0000
Av.	....	....	....	....	0.0	4.10	–	–	.0000	.0011	.13	.0242	–

The samples were collected from a faucet in a house near the source of supply.

Microscopical Examination.

April, 1888. No organisms.

Water Supply of Watertown and Belmont. — Watertown Water Supply Company.

Description of Works. — Population in 1885, of Watertown, 6,238; of Belmont, 1,639; total, 7,877. The works are owned by the Watertown Water Supply Company, and were built to supply Watertown in 1885; they were extended to Belmont in 1887. The average daily consumption in both towns in 1888 was about 210,000 gallons. The source of supply is a filter-gallery on the left bank of Charles River above the town. The gallery is built in three sections. The first section is 190 feet long and 15 feet wide, and contains about 12 to 15 feet of water. The second section is a conduit 175 feet long, 3 feet wide and 2 feet high. The third section is at right angles to the second section, and is 102 feet long and 8 feet wide. The bottoms of all the sections are on a level. Pumps force the water to an iron tank 40 feet in diameter and 40 feet in height. The tank is covered by a roof, but light and air are admitted. Distributing mains are of wrought iron lined with cement; service pipes are of enamelled iron.

Chemical Examination of Water from the Filter-Gallery of the Watertown Water Supply Company.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Exam-ination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albu-minoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
41	June 6	June 7	None.	Very slight.	0.0	7.47	–	–	.0002	.0018	.58	.0320	–
257	July 5	July 7	None.	None.	0.0	6.85	–	–	.0000	.0034	.57	.0130	–
515	Aug. 10	Aug. 11	None.	None.	0.0	7.00	–	–	.0002	.0041	.70	.0720	–
724	Sept. 8	Sept. 10	Very slight.	Very slight.	0.0	7.50	–	–	.0002	.0029	.67	.0200	–
970	Oct. 17	Oct. 19	None.	Very slight.	0.0	6.80	–	–	.0028	.0046	.64	.0260	–
1144	Nov. 10	Nov. 11	None.	None.	0.0	7.10	–	–	.0000	.0026	.67	.0280	–
1367	Dec. 8	Dec. 9	None.	None.	0.0	6.90	–	–	.0000	.0042	.70	.0190	–
	1888.												
1761	Feb. 7	Feb. 8	None.	Very slight, white.	0.0	7.45	–	–	.0000	.0028	.74	.0800	.0001
1982	Mar. 7	Mar. 10	None.	None.	0.0	6.65	–	–	.0000	.0044	.52	.0450	.0000
2201	Apr. 10	Apr. 13	None.	None.	0.0	7.00	–	–	.0000	.0052	.62	.1100	.0000
2398	May 9	May 11	None.	None.	0.0	7.25	–	–	.0000	.0022	.69	.0650	.0000
2600	June 12	June 15	None.	None.	0.0	7.50	–	–	.0000	.0020	.68	.0900	.0000
2756	July 9	July 12	None.	Slight.	0.0	7.45	–	–	.0004	.0032	.63	.0400	.0000
2902	Aug. 9	Aug. 10	None.	None.	0.0	6.75	–	–	.0000	.0046	.67	.0120	.0001
3367	Oct. 12	Oct. 15	None.	None.	0.0	7.55	–	–	.0000	.0050	.53	.0550	.0000
3522	Nov. 9	Nov. 12	None.	None.	0.0	7.40	–	–	.0000	.0062	.60	.0400	.0000
3676	Dec. 8	Dec. 10	None.	None.	0.0	7.25	–	–	.0000	.0048	.63	.1100	.0001
	1889.												
3936	Jan. 25	Jan. 26	None.	None.	0.0	6.60	–	–	.0000	.0018	.67	.0950	.0000
4005	Feb. 10	Feb. 12	None.	None.	0.0	6.45	–	–	.0000	.0030	.72	.0700	.0000
4150	Feb. 25	Feb. 28	None.	None.	0.0	6.45	–	–	.0000	.0030	.68	.0600	.0000
4294	Mar. 13	Mar. 14	None.	None.	0.0	6.40	–	–	.0000	.0028	.59	.0600	.0000
4582	Apr. 25	Apr. 26	None.	None.	0.0	6.50	–	–	.0000	.0014	.59	.0550	.0000
4648	May 10	May 13	None.	None.	0.0	6.30	–	–	.0000	.0042	.60	.0450	.0000
Av.	....	....	....	....	0.0	6.98	–	–	.0002	.0035	.64	.0540	.0000

Hardness in May, 1888, 3.5. Odor, none.—— The samples were collected from the filter-gallery or from a faucet at the pumping station while pumping.

Microscopical Examination.

	1888.							1889.					
	May.	June.	July.	Aug.	Oct.	Nov.	Dec.	Jan.	Feb.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ,	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ,	0.0	0.0	0.0	pr.	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3. Fungi,	0.0	0.0	0.0	pr.	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms,	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Groups and principal genera of organisms observed: 2. Palmellaceæ; Zoosporeæ. 3. Schizomycetes.

Chemical Examination of Water from a Tubular Well at Watertown.

[Parts per 100,000.]

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.
3167	1888. Sept. 13	Sept. 14	None.	None.	0.0	10.45	–	–	.0042	.0008	.67	.0180	.0000

Odor, none.—— The sample was collected from a tubular well near the filter-gallery of the Watertown Water Supply Company.

Microscopical Examination.

No organisms.

Chemical Examination of Water from the Tank of the Watertown Water Supply Company.

[Parts per 100,000.]

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.
971	1887. Oct. 17	Oct. 19	None.	None.	0.0	7.60	–	–	.0004	.0032	.63	.0350	–
1368	Dec. 8	Dec. 9	None.	None.	0.0	7.50	–	–	.0000	.0020	.69	.0150	–

Odor, none.——The samples were collected from the tank.

Chemical Examination of Water from Charles River at Watertown.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.	1887.											
269	July 7	July 7	Slight.	Con., brown.	0.90	6.75	2.00	4.75	.0006	.0307	.60	.0030	–
493	Aug. 8	Aug. 8	Slight.	Sli't, brown.	0.60	6.97	1.30	5.67	.0055	.0237	.59	.0350	–
710	Sept. 8	Sept. 8	Distinct.	Slight.	0.60	6.90	1.15	5.75	.0009	.0291	.62	.0130	–
912	Oct. 10	Oct. 10	Slight.	Sli't, earthy and floc't.	0.45	7.15	1.40	5.75	.0056	.0249	.75	.0260	–
1118	Nov. 8	Nov. 9	Distinct.	Sli't, white.	0.30	7.80	2.00	5.80	.0305	.0255	.88	.0400	–
	1888.	1888.											
1564	Jan. 9	Jan. 10	Distinct.	Slight.	0.90	5.70	2.00	3.70	.0038	.0298	.38	.0300	.0000
1764	Feb. 7	Feb. 8	Slight.	Con., earthy and floc't.	0.50	7.10	2.00	5.10	.0031	.0286	.48	.0300	.0000
1981	Mar. 9	Mar. 10	Slight.	Con., earthy and floc't.	0.70	5.75	2.15	3.60	.0046	.0320	.46	.0230	.0003
2182	Apr. 10	Apr. 11	Distinct.	Sli't, brown.	1.00	4.05	1.50	2.55	.0000	.0302	.34	.0100	.0004
2375	May 8	May 9	Distinct.	Con., dark brown.	0.80	6.25	2.20	4.05	.0040	.0322 **.0256**	.53	.0400	.0004
2712	July 5	July 6	Slight.	Slight.	0.40	**6.25**	**2.10**	**4.15**	.0092	.0248 **.0214**	.60	.0550	.0017
2901	Aug. 9	Aug. 10	Distinct.	Slight.	0.40	**7.95**	**1.95**	**6.00**	.0046	.0402 **.0312**	.83	.0150	.0017
3166	Sept. 13	Sept. 14	Slight.	Con., brown.	0.70	**6.95**	**2.35**	**4.60**	.0032	.0420 **.0274**	.62	.0400	.0006
3360	Oct. 12	Oct. 13	Slight.	Consid'ble.	1.70	**6.40**	**2.50**	**3.90**	.0036	.0380 **.0346**	.43	.0250	.0003
3516	Nov. 9	Nov. 10	Slight.	Sli't, earthy and floc't.	1.10	**6.20**	**2.35**	**3.85**	.0048	.0326 **.0280**	.56	.0250	.0007
3662	Dec. 6	Dec. 7	Slight.	Slight.	0.50	**4.20**	**1.35**	**2.85**	.0000	.0204 **.0164**	.42	.0300	.0004
	1889.	1889.											
3935	Jan. 25	Jan. 26	Slight.	Very slight.	0.45	**4.05**	**1.15**	**2.90**	.0000	.0184 **.0150**	.39	.0120	.0003
3996	Feb. 8	Feb. 9	Distinct.	Slight.	0.45	**4.55**	**1.10**	**3.45**	.0002	.0184 **.0146**	.43	.0150	.0004
4105	Feb. 23	Feb. 25	Distinct.	Slight.	0.50	**4.45**	**1.20**	**3.25**	.0004	.0216 **.0168**	.40	.0200	.0004
4250	Mar. 8	Mar. 9	Slight.	Consid'ble.	0.30	**4.80**	**1.45**	**3.35**	.0000	.0208 **.0172**	.41	.0180	.0008
4505	Apr. 12	Apr. 13	Distinct.	Consid'ble.	0.60	**4.75**	**1.70**	**3.05**	.0000	.0306 **.0252**	.43	.0150	.0003
4637	May 10	May 11	Distinct.	Con., brown.	1.00	**6.10**	**2.60**	**3.50**	.0076	.0430 **.0354**	.49	.0350	.0004
Av.	....	....	....	....	0.68	6.44	1.77	4.67	.0042	.0290	.53	.0252	.0005

Hardness in May, 1888, 2.3. Odor, faintly vegetable, frequently mouldy.—— The samples were collected from the canal at the Ætna Mills, Watertown.

Microscopical Examination.

	1888.						1889.					
	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ,	0.2	0.0	0.0	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ,	2.1	1.1	0.8	0.7	0.4	0.2	pr.	0.1	0.2	1.9	5.5	0.5
3. Fungi,	2.5	5.0	5.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0
4. Animal Forms,	1.1	pr.	0.7	0.1	0.1	pr.	0.0	0.0	0.1	0.6	0.3	0.8

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ, *Chlorococcus;* Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Synedra, Tabellaria;* Zygnemaceæ. 3. Schizomycetes, *Crenothrix.* 4. Protozoa; Spongiaria.

Water Supply of Wayland.

Description of Works. — Population of the town of Wayland in 1885, 1,946. Water is supplied only to Cochituate village, which is the principal village in the town. The works were built in 1878. Water is supplied to about 1,200 people. The source of supply is a small filter-gallery built close to the shore of a small storage reservoir on Snake Brook, a tributary of Lake Cochituate, which is one of the sources of the water supply of Boston. The gallery is 400 feet long, 12 inches wide and 18 inches high, with two branches, each 80 feet long, extending beneath the reservoir. The gallery is covered with from 4 to 10 feet of gravel. The reservoir covers an area of about 13 acres and its capacity is about 16,000,000 gallons. Water is distributed by gravity. Distributing mains are of cast iron; service pipes are of wrought iron, tarred. In case of fire the filter-gallery is shut off and water, taken directly from the reservoir, is pumped by water-power to increase the pressure. This supply gives trouble in the summer from the growth of *Crenothrix* in the pipes, and will be further discussed in a subsequent portion of this report.

Chemical Examination of Water from the Filter-Gallery of the Wayland Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
25	May 31	June 2	Decided, milky.	Slight, dark brown.	0.50	4.75	–	–	.0222	.0132	–	–	–
259	July 6	July 7	Decided.	Slight, dark brown.	1.30	5.62	–	–	.0280	.0367	.32	.0070	–
484	Aug. 5	Aug. 6	Distinct.	Slight.	1.20	4.85	–	–	.0024	.0308	.22	.0070	–
679	Sept. 2	Sept. 3	Decided.	Slight.	0.40	4.87	–	–	.0210	.0202	.25	.0070	–
921	Oct. 10	Oct. 11	Decided.	Consid'ble.	0.50	4.60	–	–	.0225	.0201	.22	.0130	–
1139	Nov. 9	Nov. 10	Distinct.	Slight.	0.40	4.55	–	–	.0021	.0195	.27	.0150	–
	1888.												
1553	Jan. 6	Jan. 7	Decided.	Con., dark brown.	1.00	6.35	–	–	.0091	.0269	.39	.0500	.0000
1878	Feb. 19	Feb. 23	Distinct.	Slight.	0.50	5.20	–	–	.0203	.0193	.35	.0350	.0001
1992	Mar. 11	Mar. 12	Distinct.	Very slight, white.	0.40	5.50	–	–	.0130	.0147	.42	.0800	.0002
2157	Apr. 3	Apr. 4	Slight.	Very slight.	0.35	3.75	–	–	.0072	.0122	.34	.0300	.0001
2360	May 4	May 5	Distinct.	Con., rusty.	0.30	4.55	–	–	.0190	.0122	.36	.0250	.0003
2614	June 15	June 16	Distinct.	Slight.	0.70	4.65	–	–	.0156	.0206 .0180	.25	.0180	.0001
2797	July 18	July 19	Distinct.	Slight.	0.50	4.55	–	–	.0206	.0248 .0214	.24	.0100	.0004
2962	Aug. 16	Aug. 17	Decided.	Heavy.	0.25	4.45	–	–	.0244	.0202 .0158	.24	.0080	.0001
3265	Sept. 24	Sept. 27	Distinct.	Sli't, rusty.	0.35	4.95	–	–	.0166	.0226 .0188	.30	.0300	.0002
3423	Oct. 23	Oct. 23	Distinct.	Sli't, green.	0.70	5.05	–	–	.0216	.0158 .0148	.37	.0250	.0003
3563	Nov. 16	Nov. 17	Decided.	Con., green.	0.30	4.50	–	–	.0200	.0174 .0138	.35	.0250	.0007
3723	Dec. 14	Dec. 15	Very slight.	Slight.	0.05	5.70	–	–	.0022	.0070 .0070	.58	.0950	.0002
	1889.												
3881	Jan. 19	Jan. 21	Very slight.	Very slight.	0.10	4.75	–	–	.0016	.0094 .0072	.49	.0850	.0000
4279	Mar. 9	Mar. 12	Very slight.	Con., earthy and floc't.	0.10	4.50	–	–	.0012	.0102 .0064	.36	.0500	.0001
4629	May 8	May 9	Slight.	Slight.	0.60	4.45	–	–	.0026	.0158 .0142	.33	.0350	.0002
Av.	....	....	....	....	0.50	4.96	–	–	.0140	.0186	.33	.0325	.0002

Hardness in May, 1888, 2.0. Odor, faintly vegetable, occasionally none.——The samples were collected from a faucet at the gate-house or from a faucet in a house on the main pipe very near the filter-gallery.

Microscopical Examination.

	1888.							1889.		
	June	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Mar.	May.
1. Blue-green Algæ,	0.0	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ,	0.1	0.3	0.2	pr.	pr.	0.0	pr.	0.1	2.5	0.8
3. Fungi,	45.0	35.0	1500.0	25.0	50.0	1400.0	8.0	pr.	0.0	0.0
4. Animal Forms,	pr.	pr.	0.0	0.0	0.0	0.0	0.0	0.0	1.0	4.2

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Diatomaceæ, *Asterionella*. 3. Schizomycetes, *Crenothrix*. 4. Protozoa, *Dinobyron;* Entomostraca.

Chemical Examination of Water from the Storage Reservoir of the Wayland Water Works.

[Parts per 100,000.]

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.	Chlorine.	Nitrates.	Nitrites.
	1887.												
258	July 5	July 7	Slight.	Sli't, brown.	1.10	5.02	2.15	2.87	.0022	.0439	.24	.0000	–
483	Aug. 5	Aug. 6	Slight.	Very slight, brown.	1.00	4.95	1.65	3.30	.0006	.0369	.21	.0000	–
920	Oct. 10	Oct. 11	Decided.	Very slight.	0.47	4.35	1.15	3.20	.0004	.0351	.24	.0070	–
1133	Nov. 9	Nov. 10	Distinct.	Consid'ble.	0.35	4.75	1.30	3.45	.0036	.0315	.30	.0100	–
	1888.												
1554	Jan. 6	Jan. 7	Distinct.	Slight.	1.40	5.95	2.95	3.00	.0059	.0609	.26	.0250	.0000
1879	Feb. 19	Feb. 23	Slight.	Very slight.	0.30	4.45	1.35	3.10	.0046	.0155	.22	.0350	.0000
1991	Mar. 11	Mar. 12	Slight.	None.	0.20	3.75	0.85	2.90	.0006	.0154	.25	.0200	.0000
2156	Apr. 3	Apr. 4	Very slight.	Very slight.	0.70	3.10	1.45	1.65	.0002	.0235	.20	.0080	.0000
2359	May 4	May 5	Slight.	Slight.	1.00	3.65	1.45	2.20	.0004	.0262	.23	.0300	.0002
2613	June 15	June 16	Slight.	Slight.	1.50	4.10	1.85	2.25	.0004	.0366 .0272	.20	.0050	.0001
2796	July 18	July 19	Very slight.	Very slight, white.	0.90	4.45	1.80	2.65	.0004	.0396 .0364	.24	.0050	.0001
2963	Aug. 16	Aug. 17	Distinct.	Very slight, white.	0.40	3.85	1.40	2.45	.0016	.0284 .0244	.21	.0030	.0000
3264	Sept. 24	Sept. 27	Slight.	Slight.	1.30	4.95	2.50	2.45	.0070	.0344 .0336	.20	.0050	.0003
3422	Oct. 22	Oct. 23	Slight.	Slight.	1.50	5.10	2.55	2.55	.0032	.0368 .0302	.25	.0100	.0001
3564	Nov. 16	Nov. 17	Very slight.	Slight.	1.30	4.50	2.00	2.50	.0038	.0348 .0284	.23	.0100	.0004
3724	Dec. 14	Dec. 15	Very slight.	Slight.	0.50	3.65	1.45	2.20	.0002	.0136 .0128	.25	.0070	.0003

Chemical Examination of Water from the Storage Reservoir of the Wayland Water Works — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
3882	Jan. 19	Jan. 21	Slight.	Very slight.	0.50	3.45	1.50	1.95	.0014	.0172 .0164	.22	.0200	.0001
4280	Mar. 9	Mar. 12	Slight.	Slight.	0.50	3.00	1.20	1.80	.0014	.0196 .0138	.17	.0080	.0001
4511	Apr. 14	Apr. 15	Very slight.	Slight.	0.75	3.20	1.40	1.80	.0018	.0236 .0186	.20	.0030	.0000
4630	May 8	May 9	Slight.	Sli't, light colored.	0.90	3.55	1.45	2.10	.0012	.0216 .0196	.23	.0050	.0002
Av.	....	....	....	....	0.83	4.44	1.59	2.85	.0020	.0298	.23	.0108	.0001

Hardness in May, 1888, 1.6. Odor, faintly vegetable. —— The samples were collected from the reservoir at the surface, with the exception of No. 258, which was collected 6 feet beneath the surface.

Microscopical Examination.

	1888. June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	1889. Jan.	Mar.	Apr.	May.
1. Blue-green Algæ,	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ,	0.1	0.6	0.2	0.1	0.2	0.2	1.1	0.4	pr.	0.1	8.6
3. Fungi,	0.0	0.2	0.0	0.0	0.0	pr.	pr.	0.0	0.0	0.0	0.0
4. Animal Forms,	0.5	0.7	1.2	pr.	pr.	0.0	0.0	0.0	pr.	pr.	15.6

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ, *Chlorococcus;* Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Asterionella, Synedra, Tabellaria.* 3. Schizomycetes. 4. Protozoa, *Dinobryon;* Rotifera; Entomostraca.

Water Supply of Webster. — Slater Manufacturing Company.

Description of Works. — Population in 1885, 6,220. The works are owned by the Slater Manufacturing Company, and were built in 1881. The average daily consumption in 1888 was about 200,000 gallons. The source of supply is Lake Chaubunagungamaug in Webster. The area of the lake is 1,250 acres, as estimated from the new topographical map of Massachusetts. It is very irregular in outline and contains several small islands. The bottom of the lake

is stony and gravelly, and, in some places, muddy. A dam at the outlet raises the former natural surface of the lake about two feet, and in some places the depth of water is slight, but there is very little vegetable growth. The watershed of 9.73 square miles, including the area of the lake, as estimated from the new topographical map of Massachusetts, consists of farming and woodland, and contains a very small population. The soil is generally gravelly and rocky, but there are also a few small areas of swamp and meadow land, principally near the south-western shore of the lake. Pumps force the water to an open distributing reservoir and to the town. The reservoir is 300 feet long, 75 feet wide and 10 feet deep. The bottom is of rock, and the slopes are paved. Distributing mains are of cast iron. Service pipes are of galvanized iron.

Chemical Examination of Water from Lake Chaubunagungamaug.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
215	June 28	June 29	Sli't, milky.	None.	0.15	2.27	0.77	1.50	.0004	.0139	.18	.0000	–
432	July 28	July 29	Very slight.	Very slight.	0.10	2.30	0.45	1.85	.0000	.0094	.17	.0040	–
646	Aug. 30	Aug. 31	Very slight.	None.	0.00	2.25	0.70	1.55	.0001	.0161	.16	.0030	–
844	Sept. 22	Sept. 23	Very slight.	Very slight.	0.00	2.55	0.90	1.65	.0000	.0158	.15	.0030	–
1069	Oct. 28	Oct. 29	Very slight.	Very slight, white.	0.00	2.05	0.50	1.55	.0000	.0146	.16	.0030	–
1282	Nov. 30	Dec. 1	Very slight.	Very slight.	0.00	2.30	0.85	1.45	.0000	.0133	.19	.0060	–
1496	Dec. 28	Dec. 29	Very slight.	Very slight, white.	0.10	2.20	0.50	1.70	.0000	.0126	.22	.0070	–
	1888.												
1703	Jan. 30	Jan. 31	Slight.	Very slight, white.	0.10	2.35	0.90	1.45	.0000	.0117	.14	.0050	.0001
1944	Mar. 2	Mar. 5	Slight.	Very slight.	0.10	2.10	0.55	1.55	.0003	.0113	.17	.0090	.0000
2115	Mar. 27	Mar. 28	Slight.	None.	0.00	2.10	0.50	1.60	.0000	.0126	.16	.0050	.0001
2325	Apr. 27	Apr. 30	Slight.	Slight.	0.05	1.80	0.70	1.10	.0014	.0116	.15	.0030	.0000
2521	May 28	May 29	Slight.	Slight.	0.10	1.90	0.65	1.25	.0000	.0118	.14	.0030	.0000
Av.	....	....	....	....	0.06	2.18	0.66	1.52	.0002	.0129	.17	.0043	–

Hardness in May, 1888, 0.8. Odor, faintly vegetable. —— The samples were collected from a faucet at the pumping station while pumping.

Microscopical Examination.

	1888.		
	March.	April.	May.
1. Blue-green Algæ,	0.0	0.0	0.0
2. Other Algæ,	pr.	pr.	pr.
3. Fungi,	0.0	0.0	0.0
4. Animal Forms,	0.0	0.0	0.0

Groups and principal genera of organisms observed: 2. Zoosporeæ; Desmidiaceæ; Diatomaceæ.

Table showing Record of Heights of Water in Lake Chaubunagungamaug at Times when Samples of Water were collected for Analysis.

NOTE.—Heights are in feet above or below high-water mark. The sign "+" indicates above high water. The sign "—" indicates below high water.

DATE.	Height of Water.	DATE.	Height of Water.
1887.		1888.	
June 28,	+0.05	January 30,	—1.58
July 28,	+0.19	February 28,	—1.21
August 30,	0.00	March 2,	—1.17
September 22,	—0.50	March 27,	—0.33
October 28,	—1.34	April 27,	+0.04
November 30,	—1.77	May 28,	+0.29
December 28,	—1.51		

Chemical Examination of Water from the Distributing Reservoir, Webster.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Exam-ination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albu-minoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
214	June 28	June 29	Sli't, milky.	None.	0.1	2.45	0.75	1.70	.0013	.0158	.18	.0000	-
1070	Oct. 28	Oct. 29	Very slight.	Very slight.	0.0	2.15	0.50	1.65	.0004	.0124	.16	.0010	-

Odor, very faint or none.——The samples were collected from the reservoir.

WATER SUPPLY OF WELLESLEY.

Description of Works. — Population in 1885, 3,013. The works are owned by the town. Water was introduced in December, 1884. The average daily consumption in 1888 was 138,000 gallons. The source of supply is a filter-gallery on the left bank of Rosemary Brook, and about 400 feet from Charles River, supplemented by water drawn from Williams' Spring. The filter-gallery is 63 feet in length, 12 feet wide at the top of the side walls, and 11 feet wide at the bottom. The walls are of rough stone laid dry to a height of 13 feet from the bottom, and surmounted by a brick arch 12 inches in thickness, making the total inside height 17 feet 10 inches. Two manholes give access to the gallery. A direct connection is also built between Rosemary Brook and the gallery. In 1886 a well 20 feet deep and 22 feet in diameter was built at "Williams' Spring," about 1,000 feet from the filter-gallery and connected with the pump well at the pumping station by a siphon. Pumps force the water from the pump well to an open distributing reservoir, which is 133.5 feet square at the top, 73.5 feet square at the bottom, and 16 feet deep at high water. The capacity of the reservoir is about 1,150,000 gallons. The bottom is covered with a layer of concrete six inches in thickness, and the slopes are paved with stone. Beneath the stone paving a layer of concrete 10 inches in thickness extends up the slope to a level four and one-half feet below high-water mark. Distributing mains are of cast iron. Service pipes are of wrought iron coated with tar. For new service pipes wrought iron lined with cement is used.

Chemical Examination of Water from the Filter-Gallery of the Wellesley Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
81	June 11	June 11	None.	None.	0.00	7.45	–	–	.0006	.0016	.53	.1300	–
300	July 11	July 11	None.	Sli't, earthy.	0.00	8.50	–	–	.0002	.0008	.59	.0910	–
537	Aug. 13	Aug. 13	None.	None.	0.00	7.30	–	–	.0000	.0006	.54	.0850	–
780	Sept. 16	Sept. 16	Decided.	Con., e'rthy.	0.05	8.90	–	–	.0001	.0038	.70	.1950	–

Chemical Examination of Water from the Filter-Gallery of the Wellesley Water Works — Concluded.

Number.	Date of Collection.	Date of Exam-ination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albu-minoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
958	Oct. 14	Oct. 15	None.	None.	0.00	7.15	–	–	.0000	.0024	.49	.0390	–
1174	Nov. 14	Nov. 14	None.	None.	0.00	7.15	–	–	.0004	.0016	.43	.0750	–
1445	Dec. 20	Dec. 20	None.	None.	0.00	6.55	–	–	.0000	.0006	.49	.0700	–
	1888.												
1603	Jan. 17	Jan. 17	None.	None.	0.00	6.85	–	–	.0000	.0010	.48	.1000	.0001
1797	Feb. 11	Feb. 11	None.	None.	0.00	6.55	–	–	.0000	.0023	.48	.0900	.0000
2125	Mar. 31	Mar. 31	None.	None.	0.00	6.70	–	–	.0000	.0030	.38	.0650	.0000
2256	Apr. 20	Apr. 20	Very slight.	Very slight.	0.00	6.45	–	–	.0000	.0018	.40	.0800	.0001
2392	May 10	May 10	None.	None.	0.00	6.50	–	–	.0000	.0010	.40	.0700	.0000
2633	June 20	June 20	None.	None.	0.00	5.45	–	–	.0000	.0022	.45	.0400	.0000
2726	July 6	July 6	None.	None.	0.00	5.95	–	–	.0000	.0028	.49	.0350	.0000
3020	Aug. 23	Aug. 23	None.	None.	0.00	6.25	–	–	.0000	.0048	.51	.0220	.0000
3199	Sept. 18	Sept. 19	None.	None.	0.00	6.80	–	–	.0000	.0040	.55	.0400	.0000
3353	Oct. 11	Oct. 11	None.	None.	0.00	8.10	–	–	.0008	.0028	.44	.1000	.0000
3527	Nov. 12	Nov. 13	Very slight.	Sli't, earthy and floc't.	0.00	6.85	–	–	.0000	.0016	.39	.0650	.0000
3674	Dec. 8	Dec. 8	None.	None.	0.00	6.35	–	–	.0000	.0008	.34	.0600	.0000
	1889.												
3825	Jan. 7	Jan. 8	None.	None.	0.00	6.20	–	–	.0000	.0018	.37	.0500	.0000
4023	Feb. 15	Feb. 16	None.	None.	0.00	5.95	–	–	.0000	.0020	.36	.0500	.0000
4345	Mar. 20	Mar. 20	None.	None.	0.00	5.85	–	–	.0000	.0018	.39	.0600	.0000
4514	Apr. 16	Apr. 16	None.	None.	0.00	5.90	–	–	.0000	.0014	.33	.0050	.0000
4695	May 20	May 20	None.	None.	0.00	5.55	–	–	.0026	.0034	.50	.0500	.0000
Av.	....	....	....	....	0.00	6.72	–	–	.0002	.0021	.46	.0723	.0000

Hardness in May, 1888, 3.2 Odor, none.——The samples were collected from the filter-gallery, with the exception of Nos. 81, 300, 537 and 780, which were collected from a faucet at the pumping station while pumping.

Microscopical Examination.

	1888. June.	1888. July.	1888. Aug.	1888. Sept.	1888. Oct.	1888. Nov.	1888. Dec.	1889. Jan.	1889. Feb.	1889. Mar.	1889. Apr.	1889. May.
1. Blue-green Algæ, ...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	pr.	0.0	pr.	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3. Fungi, ...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, ...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Groups and principal genera of organisms observed: 2. Zoosporeæ; Diatomaceæ.

Chemical Examination of Water from the Distributing Reservoir of the Wellesley Water Works

[Parts per 100,000.]

Number.	Date of: Collection.	Date of: Examination.	Appearance: Turbidity.	Appearance: Sediment.	Appearance: Color.	Residue on Evaporation: Total.	Residue on Evaporation: Loss on Ignition.	Residue on Evaporation: Fixed.	Ammonia: Free.	Ammonia: Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
299	July 11	July 11	Very slight.	None.	0.00	7.15	–	–	.0013	.0194	.57	.0460	–
959	Oct. 14	Oct. 15	Slight.	None.	0.00	7.20	–	–	.0000	.0092	.56	.0910	–
1175	Nov. 14	Nov. 14	Very slight.	Very slight.	0.00	6.95	–	–	.0000	.0044	.58	.1000	–
1444	Dec. 20	Dec. 20	None.	None.	0.00	7.28	–	–	.0002	.0058	.63	.1200	–
	1888.												
1602	Jan. 17	Jan. 17	Slight.	Very slight.	0.00	7.50	–	–	.0004	.0067	.60	.1300	.0003
1798	Feb. 11	Feb. 11	Very slight.	Con., eart'y and floc't.	0.00	7.70	–	–	.0000	.0057	.59	.1200	.0003
2124	Mar. 31	Mar. 31	Slight.	Very slight.	0.09	6.50	–	–	.0000	.0074	.49	.0900	.0005
2257	Apr. 20	Apr. 20	Slight.	Very slight	0.10	7.05	–	–	.0000	.0084	.52	.1200	.0007
2393	May 10	May 10	Slight.	None.	0.00	7.40	–	–	.0012	.0114	.53	.1500	.0009
2727	July 6	July 6	Very slight.	Very slight.	0.00	7.65	–	–	.0010	.0110 .0062	.58	.1100	.0007
2903	Aug. 10	Aug. 10	Very slight.	Very slight.	0.00	7.85 7.45	–	–	.0008	.0082 .0046	.57	.0730	.0003
3200	Sept. 18	Sept. 19	Very slight.	Very slight, white.	0.00	6.80	–	–	.0012	.0126 .0100	.55	.1100	.0004
3354	Oct. 11	Oct. 11	Very slight.	Very slight.	0.00	8.60	–	–	.0024	.0076 .0068	.66	.1650	.0003
3528	Nov. 12	Nov. 13	Very slight.	Slight.	0.00	8.00	–	–	.0000	.0058 .0046	.58	.2000	.0004
3675	Dec. 8	Dec. 8	None.	Slight.	0.00	8.20	–	–	.0002	.0090 .0060	.58	.1750	.0002
	1889.												
3826	Jan. 7	Jan. 8	Very slight.	None.	0.00	7.90	–	–	.0000	.0098	.60	.1600	.0003
4024	Feb. 15	Feb. 16	Very slight.	Very slight.	0.00	7.00	–	–	.0000	.0090 .0040	.51	.1100	.0004
4346	Mar. 20	Mar. 20	Very slight.	Very slight.	0.00	6.65	–	–	.0002	.0054 .0036	.52	.1000	.0003
4513	Apr. 16	Apr. 16	Slight.	Slight.	0.00	6.75	–	–	.0000	.0076 .0046	.53	.0850	.0006
4696	May 20	May 20	Very slight.	Very slight.	0.00	7.55	–	–	.0018	.0070 .0052	.57	.1100	.0002
Av.	....	....	....	....	0.00	7.29	–	–	.0005	.0086	.57	.1183	.0004

Hardness in May, 1888, 3.2. Odor, generally none, occasionally disagreeable.—— The samples were collected from the reservoir at the surface. The reservoir was drawn off and cleaned just before the last sample was collected.

Microscopical Examination.

	1888.						1889.				
	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ,	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ,	3.1	1.1	pr.	0.1	0.1	0.0	0.1	0.9	0.0	0.0	pr.
3. Fungi,	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms,	pr.	0.2	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Groups and principal genera of organisms observed: 2. Palmellaceæ; Zoosporeæ, *Scenedesmus*; Diatomaceæ, *Synedra*. 4. Protozoa; Entomostraca.

Chemical Examination of Water from Rosemary Brook at Wellesley.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
957	Oct. 14	Oct. 15	Distinct.	Sli't, earthy, and floc't.	0.30	5.40	0.80	4.60	.0008	.0176	.64	.0190	–
1173	Nov. 14	Nov. 14	Very slight.	Very slight.	0.10	5.35	0.95	4.40	.0005	.0131	.65	.0300	–
1446	Dec. 20	Dec. 20	Slight.	Very slight	0.30	5.85	1.25	4.60	.0018	.0193	.67	.0250	–
	1888.												
1601	Jan. 17	Jan. 17	Slight.	Very slight.	0.20	5.90	1.20	4.70	.0020	.0117	.53	.0500	.0000
1796	Feb. 11	Feb. 11	Very slight.	Very slight, white.	0.30	6.10	2.00	4.10	.0061	.0185	.52	.0450	.0004
2123	Mar. 31	Mar. 31	Slight.	Sli't, brown.	0.40	3.80	0.90	2.90	.0004	.0244	.37	.0080	.0000
2255	Apr. 20	Apr. 20	Slight.	Sli't, brown.	0.25	4.75	1.00	3.75	.0005	.0164	.48	.0300	.0002
2391	May 10	May 10	Slight.	Slight.	0.40	5.60	1.45	4.15	.0033	.0264	.53	.0250	.0003
2632	June 20	June 20	Slight.	Sli't, brown.	0.30	5.35	1.25	4.10	.0040	.0192 .0156	.48	.0180	.0004
Av.	....	....	....	....	0.28	5.34	1.19	4.15	.0022	.0185	.54	.0278	.0002

Hardness in May, 1888, 2.2. Odor, generally none, sometimes vegetable.—— The samples were collected from the brook a short distance from its mouth and opposite the filter-gallery of the Wellesley Water Works.

Microscopical Examination.

	1888.			
	Mar.	Apr.	May.	June.
1. Blue-green Algæ,	pr.	0.0	0.0	pr.
2. Other Algæ,	pr.	pr.	pr.	0.5
3. Fungi,	0.0	0.0	0.0	0.6
4. Animal Forms,	pr.	pr.	0.0	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Diatomaceæ. 3. Schizomycetes. 4. Protozoa.

Chemical Examination of Water from Waban Lake, Wellesley.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
4753	May 30	May 31	Slight.	Slight.	0.3	4.45	1.25	3.20	.0028	.0258 .0168	.38	.0050	.0003

Odor, distinctly vegetable and grassy.——The sample was collected from near the middle of the lake.

Water Supply of Westborough.

Description of Works.—Population in 1885, 4,880. The works are owned by the town. Water was introduced in 1879. There were 550 service pipe connections in 1889. The source of supply is Sandra Pond, an artificial storage reservoir, located about two miles south of the main village, in Westborough. In 1887 the reservoir was separated into two divisions by building a dam across it at a point near the lower end where the opposite shores approached each other. The surface of the upper basin is five feet higher than the surface of the lower one at high water. The total area of both basins is said to be 51 acres. All the mud and vegetable matter was removed from the bottom of the lower basin at the time the dam was built. The maximum depth of this basin is about 15 feet. The upper basin is quite shallow, its general depth being about 8 feet. A considerable portion of the bottom of this reservoir was cleaned by removing all stumps, brush and vegetable matter. About 20 acres, however, remain as they were when the reservoir was filled for the first time. The gate-house at the lower basin was completed Nov. 13, 1887, and water was then drawn from it for the supply of the town. During the time the examinations of the Westborough supply printed in this report were made, the overflow and waste from the upper basin entered the lower one, but in 1889 the waste pipe from the upper basin was carried through the lower one and now discharges below the lower dam. The water in the upper basin is now kept sufficiently low to store the water of storms and prevent overflow into the lower one; so that the lower basin receives water from the upper one only by filtration through the gravel ridges between the basins; this quantity is sufficient at present for the supply of the town.

The watershed of Sandra Pond is generally farming land with considerable woodland. Its area is about 700 acres, and it contains a very small population. The water is distributed by gravity. Distributing mains are of cast iron. Service pipes are of wrought iron. Complaints of a disagreeable taste and odor in the water supplied to consumers were made during every year after the works were constructed until 1888.

Chemical Examination of Water from the Storage Reservoir of the Westborough Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
101	June 14	June 15	Slight.	Slight.	0.70	3.42	1.65	1.77	.0016	.0267	.21	.0090	–
316	July 12	July 13	Slight.	Very slight.	0.60	3.35	1.55	1.80	.0006	.0263	.15	.0070	–
520	Aug. 11	Aug. 12	Slight.	Very slight.	0.80	3.77	1.65	2.12	.0008	.0330	.22	.0030	–
756	Sept. 13	Sept. 14	Very slight.	Very slight.	0.20	3.30	1.30	2.00	.0013	.0299	.22	.0030	–
946	Oct. 13	Oct. 14	Very slight.	Very slight.	0.60	3.42	1.40	2.02	.0009	.0373	.21	.0130	–
1203	Nov. 15	Nov. 17	Slight.	Slight.	0.50	2.95	1.45	1.50	.0004	.0237	.27	.0080	–
1410	Dec. 15	Dec. 15	Very slight.	Very slight.	0.70	3.50	1.55	1.95	.0004	.0264	.28	.0030	–
	1888.												
1809	Feb. 13	Feb. 14	Slight.	Very slight, white.	0.55	3.40	1.40	2.00	.0098	.0194	.26	.0120	.0001
1842	Feb. 16	Feb. 17	Slight.	Very slight.	0.40	3.20	1.10	2.10	.0112	.0226	.27	.0120	.0001
2062	Mar. 20	Mar. 21	Very slight.	Very slight.	0.15	2.85	0.65	2.20	.0015	.0144	.20	.0090	.0000
2278	Apr. 20	Apr. 23	Very slight.	Slight.	0.15	2.25	0.65	1.60	.0021	.0179	.16	.0100	.0001
2456	May 18	May 18	Very slight.	None.	0.10	2.05	0.70	1.35	.0010	.0154	.15	.0060	.0000
Av.	....	....	....	....	0.45	3.12	1.25	1.87	.0026	.0244	.22	.0079	–

Hardness in May, 1888, 0.6. Odor, vegetable, frequently mouldy.——The samples were collected from a faucet near the reservoir, with the exception of No. 2278, which was collected from a faucet in the village.

Microscopical Examination.

	1888. March.	1888. April.	1888. May.
1. Blue-green Algæ,	0.0	0.0	0.0
2. Other Algæ,	pr.	pr.	pr.
3. Fungi,	0.0	0.0	0.0
4. Animal Forms,	pr.	pr.	pr.

Groups and principal genera of organisms observed: 2. Palmellaceæ; Zoosporeæ; Diatomaceæ. 4. Protozoa; Entomostraca.

Water Supply of Westborough Insane Hospital, Westborough.

This is a supply to a public institution which has a population averaging about 500 people. The works were built in 1886. The source of supply is a system of tubular wells near the shore of Chauncy Pond. The wells are 32 in number, two inches in diameter and in some cases 50 feet deep. Water is pumped to an open iron tank 23 feet in diameter and 40 feet in height. The tank rests on the top of a brick tower 70 feet in height. Distributing mains are of cast iron; service pipes are of galvanized iron and lead.

Chauncy Pond has an area of about 205 acres, and was used as a source of water supply for the Reform School, which was located in the buildings now occupied by the hospital.

Chemical Examination of Water from the Tubular Wells at the Westborough Insane Hospital.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.		Nitrates.	Nitrites.
	1887.												
100	June 14	June 15	Sli't, milky.	None.	0.00	11.40	–	–	.0456	.0022	.42	.0000	–
318	July 12	July 13	None.	None.	0.00	11.25	–	–	.0420	.0030	.44	.0070	–
553	Aug. 15	Aug. 16	None.	None.	0.00	11.25	–	–	.0365	.0029	.40	.0000	–
747	Sept. 12	Sept. 13	Sli't, milky.	None.	0.05	11.20	–	–	.0352	.0023	.43	.0070	–
1389	Dec. 12	Dec. 14	Very slight, milky.	None.	0.10	11.35	–	–	.0442	.0060	.41	.0010	–
	1888.												
1595	Jan. 16	Jan. 17	Very slight, opalescent.	None.	0.05	11.50	–	–	.0414	.0062	.41	.0050	.0001
1808	Feb. 13	Feb. 14	Very slight, milky.	None.	0.10	11.15	–	–	.0454	.0050	–	.0100	.0001
2044	Mar. 19	Mar. 20	None.	None.	0.10	11.10	–	–	.0438	.0050	.45	.0060	.0000
2226	Apr. 16	Apr. 17	Decided, opalescent	None.	0.10	11.35	–	–	.0556	.0079	.42	.0020	.0000
2429	May 15	May 16	Milky.	None.	0.10	11.35	–	–	.0560	.0058	.43	.0000	.0000
2666	June 26	June 27	Sli't, milky.	None.	0.05	11.30	–	–	.0422	.0058 .0042	.43	.0020	.0000
2792	July 18	July 19	Decided, milky.	None.	0.00	11.85	–	–	.0508	.0042 .0024	.42	.0020	.0000
2938	Aug. 15	Aug. 16	Milky.	Very slight, black.	0.10	11.65	–	–	.0508	.0044	.44	.0050	.0000
3201	Sept. 18	Sept. 19	Very slight.	Very slight, earthy.	0.00	11.00	–	–	.0480	.0038	.43	.0050	.0000

Chemical Examination of Water from the Tubular Wells at the Westborough Insane Hospital — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
3372	Oct. 16	Oct. 17	Sli't, milky.	None.	0.00	10.95	–	–	.0590	.0030 .0030	.40	.0040	.0000
3581	Nov. 20	Nov. 21	Very slight, milky.	None.	0.00	10.60	–	–	.0552	.0048 .0048	.41	.0080	.0000
3701	Dec. 12	Dec. 13	Sli't, milky.	None.	0.10	11.45	–	–	.0544	.0054 .0046	.41	.0050	.0001
	1889.												
3860	Jan. 16	Jan. 17	Very slight. milky.	None.	0.10	11.30	–	–	.0512	.0046	.42	.0040	.0001
4037	Feb. 19	Feb. 20	Very slight, milky.	Very slight.	0.20	11.45	–	–	.0488	.0042	.44	.0030	.0000
4337	Mar. 19	Mar. 20	Sli't, milky	Very slight.	0.20	11.50	–	–	.0504	.0052	.44	.0030	.0000
4519	Apr. 16	Apr. 17	Distinct, milky.	Very slight.	0.20	11.45	–	–	.0624	.0058	.42	.0020	.0000
4663	May 14	May 15	Sli't, milky.	None.	0.10	11.35	–	–	.0520	.0048	.43	.0030	.0000
Av.	....	....	....	....	0.08	11.36	–	–	.0487	.0047	.42	.0038	.0000

Hardness in July, 1887, 5.9; in May, 1888, 6.0. Odor, generally none, occasionally peculiar. —— The samples were collected from a faucet at the pumping station while pumping.

Microscopical Examination.

March, 1888, to May, 1889, inclusive, no organisms.

Chemical Examination of Water from a Tubular Well at Westborough Insane Hospital.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
555	Aug. 15	Aug. 16	None.	None.	0.0	12.10	–	–	.0210	.0010	.40	.0000	–

The sample was collected from the tubular well nearest the pumping station at the Westborough Insane Hospital. The well was disconnected from the suction pipe for the purpose of obtaining a sample of the water.

Chemical Examination of Water from Chauncy Pond in Westborough.

[Parts per 100,000.]

Number.	Date of — Collection.	Date of — Examination.	Appearance. — Turbidity.	Appearance. — Sediment.	Appearance. — Color.	Residue on Evaporation. — Total.	Residue on Evaporation. — Loss on Ignition.	Residue on Evaporation. — Fixed.	Ammonia. — Free.	Ammonia. — Albuminoid.	Chlorine.	Nitrogen as — Nitrates.	Nitrogen as — Nitrites.
	1887.												
317	July 12	July 13	Slight.	None.	0.60	4.60	1.60	3.00	.0012	.0289	.27	.0040	–
552	Aug. 15	Aug. 16	Slight.	Slight.	0.50	4.37	2.07	2.30	.0004	.0297	.27	.0000	–
	1888.												
2665	June 26	June 27	Distinct.	None.	0.60	4.05	1.75	2.30	.0004	.0376 .0226	.30	.0030	.0000
2793	July 18	July 19	Distinct.	Very slight, white.	0.70	2.90	1.15	1.75	.0008	.0344 .0276	.29	.0000	.0001
2939	Aug. 15	Aug. 16	Distinct.	Very slight.	0.45	3.85	1.70	2.15	.0000	.0296 .0218	.29	.0030	.0003
3411	Oct. 19	Oct. 20	Distinct.	Sli't, green.	0.50	3.90	1.75	2.15	.0004	.0336 .0222	.28	.0050	.0001
Av.	....	....	....	....	0.56	3.68	1.59	2.09	.0005	.0320	.28	.0025	.0001

Odor, vegetable, occasionally mouldy.—The samples were collected from the pond near the surface, with the exception of No. 3411, which was collected five feet beneath the surface. The samples were collected from near the point where the Reform School formerly drew its water.

Microscopical Examination.

	1888. — June.	1888. — July.	1888. — Aug.	1888. — Oct.
1. Blue-green Algæ,	0.2	0.5	0.1	0.2
2. Other Algæ,	0.8	1.1	2.9	52.3
3. Fungi,	pr.	0.0	0.2	pr.
4. Animal Forms,	pr.	0.1	1.2	0.1

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Melosira*, *Tabellaria*. 3. Schizomycetes. 4. Protozoa, *Peridinium;* Spongiaria; Rotifera; Entomostraca.

Water Supply of West Brookfield.

Description of Works.—Population in 1885, 1,747. The town is supplied with water by several aqueduct companies from springs in the hills about the town. The water is distributed by gravity and the distributing mains are in most cases very small. The more important supplies are described below.

1. The Cement Aqueduct Company. — This company introduced water in 1872, and supplied about 40 families in 1887. The sources of supply are two collecting galleries on the side of a hill. One gallery is 130 feet long, 3 feet wide and 6 feet deep. The second gallery is 30 feet long, 3 feet wide and 6 feet deep. Distributing mains are of wrought iron lined with cement; service pipes are of lead.

2. Quaboag Aqueduct Company. — This company introduced water about the year 1852, and supplied about 40 families in 1887. The sources of supply are two wells. Water is distributed by gravity. Distributing mains and service pipes are of lead.

3. West Brookfield Aqueduct Company. — This company introduced water about 1838, and supplied about 60 families in 1887. The sources of supply are two collecting galleries on the side of a hill. One gallery is about 160 feet long, $2\frac{1}{2}$ feet wide, and 8 feet deep. The second gallery is about ten feet long, 2 feet wide and 4 feet deep. Distributing mains and service pipes are of lead.

Chemical Examination of Water from the Cement Aqueduct Company's Springs, West Brookfield.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1887.												
114	June 15	June 16	None.	None.	0.0	3.30	–	–	.0001	.0008	.09	.0060	–
541	Aug. 14	Aug. 15	None.	None.	0.0	3.55	–	–	.0002	.0002	.12	.0130	–
	1888.												
1591	Jan. 13	Jan. 14	None.	None.	0.0	3.00	–	–	.0000	.0006	.12	.0250	.0000
2221	Apr. 16	Apr. 17	None.	None.	0.0	2.75	–	–	.0000	.0008	.13	.0150	.0000
Av.	....	....	....	....	0.0	3.15	–	–	.0001	.0006	.12	.0148	–

Odor, none. —— The samples were collected from a faucet in the village.

Microscopical Examination.

April, 1888. No organisms.

Chemical Examination of Water from the Quaboag Aqueduct Company's Springs, West Brookfield.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance: Turbidity.	Appearance: Sediment.	Appearance: Color.	Residue on Evaporation: Total.	Residue on Evaporation: Loss on Ignition.	Residue on Evaporation: Fixed.	Ammonia: Free.	Ammonia: Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
542	Aug. 15	Aug. 15	None.	None.	0.0	3.80	–	–	.0000	.0002	.13	.0000	–
	1888.												
1587	Jan. 13	Jan. 14	None.	None.	0.0	3.80	–	–	.0001	.0006	.14	.0100	.0000
2228	Apr. 16	Apr. 17	None.	None.	0.0	3.10	–	–	.0000	.0008	.17	.0250	.0000
Av.	....	....	....	....	0.0	3.57	–	–	.0000	.0005	.15	.0117	.0000

Odor, none. —— The samples were collected from a faucet in the village.

Microscopical Examination.

April, 1888. 1. Blue-green algæ, 0.0; 2. Other algæ, pr.; 3. Fungi, 0.0; 4. Animal forms, 0.0.
Groups and principal genera of organisms observed: 2. Diatomaceæ.

Chemical Examination of Water from the West Brookfield Aqueduct Company's Springs.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance: Turbidity.	Appearance: Sediment.	Appearance: Color.	Residue on Evaporation: Total.	Residue on Evaporation: Loss on Ignition.	Residue on Evaporation: Fixed.	Ammonia: Free.	Ammonia: Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
113	June 15	June 16	None.	Slight.	0.0	5.22	–	–	.0004	.0022	.13	.0390	–
546	Aug. 15	Aug. 16	None.	Very slight.	0.0	4.77	–	–	.0000	.0004	.12	.0260	–
	1888.												
2220	Apr. 16	Apr. 17	Slight.	Con., brown.	0.0	4.20	–	–	.0000	.0054	.09	.0400	.0001
Av.	....	....	....	....	0.0	4.73	–	–	.0001	.0027	.11	.0350	–

Odor, none. —— The samples were collected from a faucet in the village.

Microscopical Examination.

April, 1888. 1. Blue-green algæ, 0.0; 2. Other algæ, pr.; 3. Fungi, 0.0; 4. Animal forms, 0.0.
Groups and principal genera of organisms observed: 2. Diatomaceæ.

Water Supply of Westfield.

Description of Works. — Population in 1885, 8,961. The works are owned by the town and were built in 1874. There were 1,481 families supplied in 1888. The source of supply is Moose Meadow

Brook, in Montgomery, on which a storage and a distributing reservoir are built. The storage reservoir is located in a mountain gorge. Its area is 38 acres, and its capacity 184,000,000 gallons. The slopes are very abrupt, and the average depth of the reservoir is 15 feet; the maximum depth is 30 feet. The bottom was originally a meadow, but the muck and vegetable growth were removed when the reservoir was built. The distributing reservoir, known as Tekoa reservoir, is about 2½ miles from the storage reservoir, and is formed like the latter by a dam across Moose Meadow Brook. Its area is about 1¼ acres and its capacity is 4,500,000 gallons. The maximum depth of the reservoir is 14½ feet and the slopes are abrupt. All muck was removed from the bottom of the reservoir when it was constructed, and the bottom is of gravel and rock. Water flows from the storage to the distributing reservoir in the channel of the brook, falling about 480 feet in its course from the storage reservoir. The area of the watershed of the storage reservoir is 2 square miles; that of the distributing reservoir is about 2¼ square miles, making the total area of watershed at the outlet of the distributing reservoir 4¼ square miles. The areas are rocky and mountainous and contain a very small population. The distributing mains are of cast iron; service pipes are of wrought iron lined with cement. It is stated in the annual reports that there was a disagreeable taste and odor in the water supplied to consumers during a time when water was being drawn from the bottom of the reservoir in 1876.

Chemical Examination of Water from the Storage Reservoir of the Westfield Water Works.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1887.	1887.											
130	June 16	June 17	Distinct.	None.	0.50	3.15	1.25	1.90	.0005	.0129	.06	.0020	–
374	July 20	July 21	None.	None.	0.60	3.00	0.95	2.05	.0011	.0193	.09	.0000	–
558	Aug. 16	Aug. 17	Slight.	Consid'ble.	1.00	3.55	1.57	1.98	.0006	.0213	.05	.0030	–
791	Sept. 16	Sept. 16	Decided.	Very slight.	0.40	3.35	0.95	2.40	.0002	.0166	.12	.0000	–
977	Oct. 18	Oct. 19	Slight.	Very slight.	0.70	3.20	1.10	2.10	.0000	.0172	.09	.0000	–
1193	Nov. 15	Nov. 16	Very slight.	Slight.	0.60	2.80	1.30	1.50	.0000	.0152	.15	.0040	–
1412	Dec. 15	Dec. 16	Very slight.	None.	0.60	3.45	1.10	2.35	.0003	.0150	.14	.0040	–

Chemical Examination of Water from the Storage Reservoir of the Westfield Water Works — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
1611	Jan. 16	Jan. 17	Slight.	Slight.	0.40	3.00	1.00	2.00	.0002	.0114	.07	.0120	.0000
1810	Feb. 13	Feb. 14	Very slight.	Very slight, white.	0.40	2.85	0.95	1.90	.0000	.0094	.14	.0100	.0001
2063	Mar. 20	Mar. 21	Very slight.	Very slight.	0.50	2.55	0.45	2.10	.0004	.0090	.10	.0100	.0001
2243	Apr. 18	Apr. 18	Slight.	Slight.	0.20	2.20	1.00	1.20	.0000	.0110	.08	.0060	.0002
2431	May 15	May 16	Slight.	Slight.	0.60	3.35	0.95	2.40	.0000	.0176	.06	.0020	.0001
Av.	....	....	....	....	0.54	3.04	1.05	1.99	.0003	.0147	.10	.0044	.0001

Hardness in May, 1888, 0.8. Odor, generally faintly vegetable.——The samples were collected from a faucet in the village.

Microscopical Examination.

	1888. March.	1888. April.	1888. May.
1. Blue-green Algæ,	0.0	0.0	0.0
2. Other Algæ,	pr.	pr.	pr.
3. Fungi,	0.0	0.0	pr.
4. Animal Forms,	0.0	pr.	pr.

Groups and principal genera of organisms observed: 2. Palmellaceæ; Diatomaceæ. 3. Schizomycetes. 4. Protozoa.

Water Supply of West Springfield. — West Springfield Aqueduct Company.

Description of Works. — Population in 1885, 4,448. The works are owned by the West Springfield Aqueduct Company, and were built in 1875. The source of supply is Darby Brook in West Springfield, on which a small storage reservoir is built. The area of the reservoir is about 3 acres and its maximum depth is about 14 feet. The bottom is of gravel. The watershed is uninhabited and much of it is woodland. Water is distributed by gravity. Distributing mains are of wrought iron lined with cement; service pipes are of wrought iron.

Chemical Examination of Water from the Storage Reservoir of the West Springfield Aqueduct Company.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1887.												
131	June 16	June 17	Decided.	Sli't, brown.	0.20	4.12	0.97	3.15	.0003	.0128	.16	.0000	–
418	July 27	July 28	Decided.	Slight.	0.80	–	–	–	.0006	.0224	.16	.0040	–
587	Aug. 19	Aug. 20	Decided.	Sli't, earthy.	0.70	5.55	1.50	4.05	.0029	.0270	.16	.0070	–
1192	Nov. 14	Nov. 16	Distinct.	Sli't, white.	0.10	4.45	1.05	3.40	.0000	.0149	.17	.0040	–
1428	Dec. 16	Dec. 17	Slight.	Sli't, white.	0.25	4.05	0.55	3.50	.0000	.0094	.14	.0040	–
	1888.												
1607	Jan. 16	Jan. 17	Distinct.	Very slight.	0.10	3.75	0.75	3.00	.0004	.0080	.10	.0080	.0000
1811	Feb. 13	Feb. 14	Very slight.	Sli't, white.	0.10	4.05	0.80	3.25	.0012	.0070	.16	.0080	.0002
2052	Mar. 19	Mar. 20	Very slight.	Slight.	0.25	3.65	0.60	3.05	.0004	.0083	.12	.0090	.0000
2229	Apr. 16	Apr. 17	Decided.	Sli't, brown.	0.20	3.05	0.65	2.40	.0000	.0104	.10	.0050	.0001
2478	May 21	May 22	Distinct.	Sli't, white.	0.35	4.30	1.15	3.15	.0034	.0128	.09	.0080	.0001
Av.	....	....	....	....	0.31	4.11	0.89	3.22	.0009	.0133	.14	.0057	.0001

Hardness in May, 1888, 1.8. Odor, vegetable, occasionally disagreeable.——The samples were collected from a faucet in the first or second house on the main pipe below the reservoir. There were heavy rains just previous to the collection of No. 418 and No. 587.

Microscopical Examination.

	1888.		
	March.	April.	May.
1. Blue-green Algæ, ...	0.0	0.0	0.0
2. Other Algæ, ...	0.0	pr.	pr.
3. Fungi, ...	0.0	0.0	0.0
4. Animal Forms, ...	pr.	pr.	0.0

Groups and principal genera of organisms observed: 2. Palmellaceæ; Diatomaceæ. 4. Protozoa.

Water Supply of Weymouth.

Description of Works.—Population in 1885, 10,740. The works are owned by the town. Water was introduced in 1885; the average daily consumption in 1888 was estimated to have been about

563,000 gallons. The source of supply is Great Pond in Weymouth. The area of the pond is 290 acres and its general depth is said to be about 12 feet. Some portions of the pond are quite shallow. The watershed of 631 acres, exclusive of the area of the pond, contains a small population, and there is considerable swamp land in the vicinity of the pond. Water flows by gravity to a pumping station, from which a portion of it is distributed by gravity to the lower parts of the town. The remainder is pumped to an open iron tank, 40 feet in diameter and 75 feet in height, from which it is distributed to the high-service districts. In case of fire the high and low service systems are connected if necessary. Distributing mains are of cast iron; service pipes are generally of wrought iron, a few being of lead.

Chemical Examination of Water from Great Pond, Weymouth.

[Parts per 100,000.]

Number.	Date of: Collection.	Date of: Examination.	Appearance: Turbidity.	Appearance: Sediment.	Appearance: Color.	Residue on Evaporation: Total.	Residue on Evaporation: Loss on Ignition.	Residue on Evaporation: Fixed.	Ammonia: Free.	Ammonia: Albuminoid.	Chlorine.	Nitrogen as: Nitrates.	Nitrogen as: Nitrites.
	1887.												
38	June 4	June 6	Very slight.	None.	0.8	4.25	2.05	2.20	.0002	.0212	.46	.0000	-
284	July 8	July 8	Slight.	Sli't, brown.	1.3	4.25	1.70	2.55	.0003	.0222	.48	.0000	-
468	Aug. 2	Aug. 4	Slight.	Con., brown.	1.0	4.02	1.57	2.45	.0006	.0221	.43	.0030	-
681	Sept. 2	Sept. 6	Very slight.	Slight.	0.7	4.08	1.62	2.46	.0011	.0222	.45	.0030	-
896	Oct. 5	Oct. 7	Very slight.	Slight.	0.9	3.90	1.65	2.25	.0013	.0237	.48	.0090	-
1361	Dec. 7	Dec. 9	Very slight.	Very slight, white.	0.9	4.00	1.90	2.10	.0008	.0202	.52	.0030	-
	1888.												
1776	Feb. 4	Feb. 8	Very slight.	Very slight, white.	0.8	4.60	2.10	2.50	.0024	.0253	.48	.0080	.0000
Av.	....	....	....	....	0.9	4.16	1.80	2.36	.0010	.0224	.47	.0037	-

Odor, faintly vegetable.—— The samples were collected from a faucet at the pumping station while pumping, with the exception of No. 38, which was collected from the pond six feet beneath the surface.

Chemical Examination of Water from Faucets in Weymouth supplied from the Weymouth Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
1550	Jan. 5	Jan. 7	Slight.	Slight.	0.9	4.20	1.85	2.35	.0012	.0216	.50	.0080	.0000
1947	Mar. 5	Mar. 5	Very slight.	Slight.	0.8	4.65	2.30	2.35	.0030	.0208	.49	.0060	.0000
2151	Apr. 3	Apr. 4	Very slight.	Very slight, white.	0.9	3.55	1.65	1.90	.0005	.0242	.48	.0050	.0000
2406	May 11	May 12	None.	None.	1.0	3.75	1.80	1.95	.0028	.0208	.44	.0100	.0001

Hardness in May, 1888, 0.3. Odor, faintly vegetable. —— The samples were collected from faucets in Weymouth near the centre of the village.

Microscopical Examination.

April and May, 1888. 1. Blue-green algæ, 0.0; 2. Other algæ, pr.; 3. Fungi, 0.0; 4. Animal forms, pr

Groups and principal genera of organisms observed: 2. Palmellaceæ; Diatomaceæ. 4. Protozoa; Entomostraca.

Chemical Examination of Water from the Tank of the Weymouth Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
897	Oct. 5	Oct. 7	Very slight.	None.	0.8	3.70	1.80	1.90	.0000	.0219	.47	.0090	–

Odor, none. —— The sample was collected from a faucet at the tank.

Water Supply of Whitman.

Description of Works. — Population in 1885, 3,595. The works are owned by the town and were built in 1883. The average daily consumption for the last six months of 1888 was 93,329 gallons. The present source of supply is a filter-gallery on the easterly shore of Hobart's Pond in Whitman. The filter-gallery was first used in the summer of 1887, but its use was afterwards discontinued for a time. The supply of the town has been drawn from it continuously since May 28, 1888. The filter-gallery is built in two sections.

The first section is 100 feet long, 15 feet wide and 14 feet high; its bottom is about 12 feet below high water in the pond. At the northerly end of this section is a smaller gallery, 416 feet long, 18 inches wide and 20 inches high. The arch and side walls are of brick. There is also a direct connection between the filter-gallery and the pond. Hobart's Pond is a mill pond on the Shumatuscacant River, one of the headwaters of the Taunton River, and was formed many years ago. Its area is 175 acres. It is very shallow and much of the area of the pond is covered with a growth of water bushes and aquatic plants. The capacity of the pond above a plane three feet below high water is said to be 58,500,000 gallons. The area of the watershed of the river at the outlet of Hobart's Pond is 6.4 square miles, as estimated from the new topographical map of Massachusetts. It includes the villages of Abington and North Abington, and a small portion of Whitman. Pumps force the water from the filter-gallery to the distributing mains and to an open iron tank situated on the opposite side of the village from the pumping station. The tank is 20 feet in diameter and 105 feet in height. The distributing mains are of wrought iron lined with cement. Service pipes are of wrought iron and of lead; the latter is used for all extensions.

Chemical Examination of Water from the Filter-Gallery of the Whitman Water Works.

[Parts per 100,000.]

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.
	1887.												
497	Aug. 8	Aug. 8	Decided.	Very slight.	1.30	7.80	–	–	.0199	.0324	.61	.0130	–
922	Oct. 10	Oct. 11	Slight.	Slight.	0.40	6.70	–	–	.0085	.0210	.91	.0260	–
	1888.												
2801	July 19	July 20	Decided.	Con., rusty.	0.70	6.35	–	–	.0226	.0326 .0274	.78	.0020	.0003
2990	Aug. 20	Aug. 21	Decided.	Slight.	0.40	6.15	–	–	.0218	.0316 .0264	.76	.0050	.0018
3275	Sept. 27	Sept. 28	Distinct.	Sli't, brown.	0.10	6.00	–	–	.0126	.0212 .0176	.65	.0200	.0005
3420	Oct. 22	Oct. 23	Slight.	Slight.	0.05	5.70	–	–	.0058	.0124 .0094	.62	.0280	.0004
3584	Nov. 21	Nov. 22	Distinct, milky.	Sli't, earthy.	0.05	5.95	–	–	.0048	.0124 .0092	.70	.0550	.0003
3736	Dec. 18	Dec. 19	Slight.	Sli't, white.	0.05	5.40 5.05	–	–	.0060	.0052 .0036	.72	.0120	.0001

Chemical Examination of Water from the Filter-Gallery of the Whitman Water Works — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
3890	Jan. 22	Jan. 23	Distinct.	Con., earthy and floc't.	0.40	4.40	–	–	.0000	.0158 .0128	.64	.0280	.0001
4147	Feb. 27	Feb. 28	Very slight.	Very slight, earthy.	0.10	4.35	–	–	.0014	.0124	.67	.0150	.0002
4397	Mar. 26	Mar. 27	Very slight.	Very slight.	0.20	4.60	–	–	.0074	.0096	.66	.0250	.0001
4557	Apr. 23	Apr. 24	Sli't, milky.	Very slight.	0.15	4.55	–	–	.0068	.0154 .0134	.69	.0080	.0002
4741	May 27	May 28	Decided.	Very slight.	0.40	5.40	–	–	.0126	.0226 .0218	.68	.0040	.0007
Av.	....	....	....	....	0.33	5.51	–	–	.0100	.0188	.70	.0186	.0004

Hardness in October, 1887, 2.3. Odor, frequently vegetable and mouldy.——The samples were collected from the filter-gallery.

Microscopical Examination.

	1888. July.	Aug.	Sept.	Oct.	Nov.	Dec.	1889. Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ,	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ,	pr.	0.0	0.0	pr.	pr.	pr.	pr.	pr.	0.3	0.0	pr.
3. Fungi,	750.0	25.0	0.0	0.0	0.0	pr.	0.0	pr.	5.0	0.0	0.0
4. Animal Forms,	pr.	pr.	0.0	0.0	pr.	0.0	0.0	pr.	0.0	0.0	0.0

Groups and principal genera of organisms observed: 2. Zoosporeæ; Desmidiaceæ; Diatomaceæ. 3. Schizomycetes, *Crenothrix*. 4. Protozoa.

Chemical Examination of Water from Hobart's Pond in Whitman.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
66	June 9	June 10	–	–	–	7.77	3.67	4.10	.0137	.0789	0.69	.0000	–
301	July 11	July 11	Decided.	Con., brown	2.30	7.40	2.60	4.80	.0032	.0836	0.65	.0000	–
924	Oct. 10	Oct. 11	Decided.	Consid'ble.	1.00	8.00	1.85	6.15	.0020	.0454	0.96	.0100	–
1369	Dec. 9	Dec. 10	Slight.	Very slight.	1.00	6.30	1.80	4.50	.0320	.0322	0.91	.0150	–

Chemical Examination of Water from Hobart's Pond in Whitman — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
1750	Feb. 3	Feb. 4	Distinct.	Slight.	0.80	7.90	2.35	5.55	.0240	.0326	1.00	.0330	.0005
1953	Mar. 6	Mar. 7	Slight.	Sli't, white.	0.40	4.35	1.60	2.75	.0065	.0207	0.49	.0150	.0001
2167	Apr. 9	Apr. 10	Distinct.	Sli't, brown.	0.70	4.45	1.75	2.70	.0015	.0340	0.56	.0080	.0003
2376	May 8	May 9	Decided.	Con., brown.	1.10	6.50	2.45	4.05	.0054	.0532	0.76	.0050	.0001
2802	July 19	July 20	Distinct.	Sl't, rusty.	1.70	7.30	2.50	4.80	.0000	.0676 .0538	0.83	.0020	.0002
2830	July 23	July 25	Slight.	Brown.	1.50	6.95	2.75	4.20	.0054	.0666 .0426	0.82	.0070	.0002
2989	Aug. 20	Aug. 21	Distinct.	Sli't, green.	0.90	6.95	2.20	4.75	.0012	.0514 .0342	0.77	.0050	.0001
3274	Sept. 27	Sept. 28	Distinct.	Slight.	1.00	5.15	2.15	3.00	.0026	.0406 .0338	0.51	.0050	.0002
3419	Oct. 22	Oct. 23	Slight.	Sli't, brown.	1.20	6.10	2.50	3.60	.0046	.0344 .0284	0.68	.0060	.0003
3583	Nov. 21	Nov. 22	Slight.	Slight.	1.50	5.40	2.30	3.10	.0030	.0288 .0268	0.64	.0150	.0004
3735	Dec. 18	Dec. 19	Slight.	Slight.	0.45	5.05	1.65	3.40	.0018	.0182 .0144	0.69	.0450	.0003
	1889.												
3944	Jan. 29	Jan. 30	Distinct.	Very slight.	0.25	4.25	1.30	2.95	.0028	.0180 .0152	0.56	.0300	.0003
4146	Feb. 27	Feb. 28	Distinct.	Very slight.	0.45	5.00	1.45	3.55	.0024	.0300 .0244	0.72	.0210	.0004
4398	Mar. 26	Mar. 27	Slight.	Slight.	0.50	4.70	1.50	3.20	.0022	.0306 .0264	0.69	.0150	.0002
4558	Apr. 23	Apr. 24	Decided.	Con., green.	0.90	4.90	1.90	3.00	.0000	.0442 .0356	0.69	.0030	.0003
4740	May 27	May 28	Slight.	Slight.	1.30	6.70	2.85	3.85	.0086	.0584 .0510	0.80	.0030	.0007
Av.	....	....	....	....	1.00	6.58	2.26	4.32	.0061	.0435	0.72	.0122	.0003

Hardness in May, 1888, 1.8. Odor, vegetable, frequently mouldy.——The samples were collected from the surface of the pond near its outlet, with the exception of No. 66, which was collected from about 4 feet beneath the surface.

Microscopical Examination.

	1888. July.	1888. July.	1888. Aug.	1888. Sept.	1888. Oct.	1888. Nov.	1888. Dec.	1889. Jan.	1889. Feb.	1889. Mar.	1889. Apr.	1889. May.
1. Blue-green Algæ, ...	pr.	0.0	0.0	pr.	0.0	0.0	pr.	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	11.7	21.9	44.3	0.4	pr.	0.2	0.5	pr.	0.1	1.7	0.1	0.5
3. Fungi, ...	0.1	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, ...	50.9	2.8	24.0	pr.	0.0	0.2	0.0	pr.	2.0	0.8	0.1	0.4

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ, *Chlorococcus;* Zoosporeæ, *Raphidium, Scenedesmus;* Desmidiaceæ, *Closterium, Staurastrum;* Diatomaceæ, *Melosira, Synedra, Tabellaria;* Zygnemaceæ. 3. Schizomycetes. 4. Protozoa, *Dinobryon, Peridinium, Trachelomonas;* Spongiaria; Rotifera; Entomostraca.

Water Supply of Williamstown. — Williamstown Aqueduct Company.

Description of Works. — Population in 1885, 3,729. The works are owned by the Williamstown Aqueduct Company and were built in 1859. About 1,500 people were supplied in 1887. The source of supply is a spring near the base of a mountain southwest of the village. The water of the spring was originally stored in a covered basin, 12 feet long, 10 feet wide and 5 feet deep. In 1887 a new reservoir was built just below the old one, 50 feet long, 30 feet wide and 5 feet deep. About Dec. 1, 1887, the new reservoir was covered. Water is distributed by gravity. Distributing mains are of cast iron; service pipes are of wrought iron. Another aqueduct company built works in 1888 to supply water from Sherman Spring, situated southeast of the village, but consolidated with the Williamstown Aqueduct Company a short time after the works were completed.

Chemical Examination of Water from a Faucet in Williamstown, supplied from the Works of the Williamstown Aqueduct Company.

[Parts per 100,000.]

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.
	1887.												
56	June 8	June 9	None.	None.	0.0	14.45	–	–	.0002	.0008	.10	.0650	–
280	July 7	July 8	None.	None.	0.0	14.50	–	–	.0004	.0004	.08	.0200	–
492	Aug. 6	Aug. 8	None.	None.	0.0	14.00	–	–	.0002	.0002	.08	.0460	–
754	Sept. 12	Sept. 14	None.	None.	0.0	14.15	–	–	.0000	.0000	.09	.0390	–
889	Oct. 3	Oct. 6	None.	Sli't, earthy.	0.0	13.85	–	–	.0000	.0016	.08	.0580	–
1107	Nov. 3	Nov. 5	None.	Slight.	0.0	14.20	–	–	.0000	.0024	.05	.0500	–
1403	Dec. 9	Dec. 15	None.	None.	0.0	14.05	–	–	.0000	.0000	.06	.0500	–
	1888.												
1575	Jan. 6	Jan. 11	None.	None.	0.0	14.15	–	–	.0000	.0006	.05	.0600	–
1733	Feb. 1	Feb. 2	None.	None.	0.0	13.65	–	–	.0000	.0006	.10	.0450	.0000
1965	Mar. 5	Mar. 7	Very slight.	Very slight.	0.0	13.60	–	–	.0000	.0020	.05	.0450	.0000
2170	Apr. 9	Apr. 10	None.	Slight.	0.0	13.10	–	–	.0000	.0000	.05	.0600	.0000
2349	May 2	May 3	None.	None.	0.0	13.80	–	–	.0000	.0000	.07	.0450	.0000
Av.	....	....	....	....	0.0	13.96	–	–	.0001	.0007	.07	.0486	.0000

Hardness in May, 1888, 13.8. Odor, none. —— The samples were collected from a faucet in the village, with the exception of No. 56, which was collected from the spring. The faucet from which the samples were collected is supplied with water from the old source of supply.

Microscopical Examination.

May, 1888. No organisms.

Chemical Examination of Water from Sherman Spring, Williamstown.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1889.												
3830	Jan. 7	Jan. 8	Distinct, milky.	None.	0.05	8.20	–	–	.0000	.0008	.04	.0070	.0000

Odor, none.—— The sample was collected from the spring. Recent heavy rains had disturbed the water at the time the sample was collected.

Water Supply of Winchendon.

Population in 1885, 3,872. A small number of families in this town are supplied with water by gravity from three springs on Benjamin Hill. The analysis of water drawn from the spring supplying the largest number of families is given below. An analysis of water from a test well, made in connection with investigations for a public water supply for the town, is also given.

Chemical Examination of Water from a Spring on Benjamin Hill, Winchendon.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1888.												
3004	Aug. 21	Aug. 22	Very slight.	Sli't, rusty, brown.	0.0	3.60	–	–	.0002	.0046 .0042	.07	.0120	.0003

Odor, none.—— The sample was collected from a faucet in the village.

Microscopical Examination.

1. Blue-green algæ, 0.0; 2. Other algæ, 0.3; 3. Fungi, 0.0; 4. Animal forms, pr.

Groups and principal genera of organisms observed: 2. Diatomaceæ. 4. Protozoa; Annelida.

Chemical Examination of Water from a Tubular Well in Winchendon.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1888.												
3039	Aug. 29	Aug. 30	Very slight.	None.	0.0	4.55	–	–	.0004	.0004	.04	.0030	.0000

Odor, none.—— The sample was collected from a tubular well about 1½ miles east of Winchendon Village, and not far from Prentiss Bridge where the Cheshire Railroad crosses Miller's River.

Water Supply of Winchester.

Description of Works. — Population in 1885, 4,390. The works are owned by the town, and were built in 1873. There were 926 water takers in 1888. The source of supply is a storage reservoir in Winchester and Stoneham. The area of the reservoir is 63 acres and its capacity is 259,000,000 gallons. Its maximum depth is 25 feet and its average depth 13 feet. The watershed of 392 acres, exclusive of the area of the reservoir, is generally well wooded and is uninhabited. The principal portion of the town is supplied by gravity directly from the storage reservoir. The higher portions of the town are supplied from the high-service system, the water for which is pumped by a windmill from the storage reservoir to a small covered distributing reservoir and to the high-service distributing pipes. A steam pump is also provided for use when the wind power is insufficient. It was used six times during the year 1889. The walls of the distributing reservoir are perpendicular, and are built of stone laid in cement; the bottom is formed of the same material. The capacity of this reservoir is 100,000 gallons. The distributing mains are of wrought iron lined with cement. Service pipes are of wrought iron lined with rubber or with cement; the latter has been used for new service pipes for several years. Complaints have been made at times during several years of a disagreeable odor and taste in the water furnished to consumers. There were no serious complaints in the years 1887 and 1888.

Chemical Examination of Water from a Faucet in Winchester, supplied from the Winchester Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
26	June 1	June 2	Very slight.	None.	0.05	5.00	1.72	3.28	.0019	.0158	.47	.0000	–
248	July 5	July 6	Decided.	Slight.	0.02	5.32	1.45	3.87	.0001	.0190	.56	.0000	–
448	July 30	July 30	Very slight.	Very slight.	0.00	4.80	0.80	4.00	.0002	.0125	.56	.0070	–
674	Sept. 2	Sept. 2	Slight.	Slight.	0.20	5.05	0.70	4.35	.0004	.0200	.49	.0030	–
883	Oct. 5	Oct. 5	Very slight.	Very slight, white.	0.30	5.20	1.15	4.05	.0008	.0241	.56	.0100	–
1092	Nov. 2	Nov. 3	Very slight.	Very slight, white.	0.10	4.75	1.10	3.65	.0000	.0235	.54	.0030	–
1320	Dec. 5	Dec. 5	Distinct.	Very slight, white.	0.10	5.45	1.35	4.10	.0068	.0222	.53	.0030	–
	1888.												
1527	Jan. 3	Jan. 4	Slight.	Very slight.	0.25	5.35	1.45	3.90	.0075	.0293	.48	.0070	.0001
1732	Feb. 2	Feb. 2	Slight.	Sli't, white.	0.10	5.55	1.45	4.10	.0079	.0245	.48	.0150	.0001

Chemical Examination of Water from a Faucet in Winchester, supplied from the Winchester Water Works — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance: Turbidity.	Appearance: Sediment.	Appearance: Color.	Residue on Evaporation: Total.	Residue on Evaporation: Loss on Ignition.	Residue on Evaporation: Fixed.	Ammonia: Free.	Ammonia: Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.	1888.											
1943	Mar. 3	Mar. 3	Distinct.	Very slight.	0.10	4.55	1.35	3.20	.0036	.0247	.44	.0100	.0001
2148	Apr. 3	Apr. 3	Very slight.	Sli't, white.	0.20	4.50	0.85	3.65	.0073	.0279	.51	.0100	.0001
2328	May 1	May 1	Distinct.	Slight.	0.10	4.95	1.20	3.75	.0034	.0262	.46	.0150	.0004
2541	June 4	June 4	Decided.	Much, e'rthy and floc't.	0.15	4.75	1.00	3.75	.0008	.0394 .0240	.42	.0120	.0004
2746	July 10	July 10	Slight.	Very slight.	0.10	4.90	1.50	3.40	.0068	.0308 .0254	.50	.0030	.0001
2866	Aug. 2	Aug. 2	Distinct.	Very slight.	0.20	4.80	1.20	3.60	.0024	.0256 .0192	.51	.0020	.0001
3074	Sept. 6	Sept. 6	Slight.	Slight.	0.20	4.70	1.20	3.50	.0052	.0296 .0216	.46	.0050	.0001
3307	Oct. 3	Oct. 4	Very slight.	Slight.	0.15	5.05	1.20	3.85	.0038	.0284 .0222	.46	.0180	.0007
3494	Nov. 2	Nov. 3	Slight.	Very slight.	0.10	5.15	1.20	3.95	.0032	.0214 .0210	.47	.0200	.0005
3646	Dec. 4	Dec. 5	Distinct.	Consid'ble.	0.20	4.85	1.25	3.60	.0022	.0198 .0190	.49	.0400	.0003
	1889.	1889.											
3823	Jan. 3	Jan. 4	Very slight.	Very slight.	0.20	5.00	1.15	3.85	.0002	.0246 .0194	.51	.0250	.0003
3975	Feb. 6	Feb. 6	Very slight.	Very slight.	0.10	3.55	0.80	2.75	.0020	.0138 .0114	.37	.0020	.0003
4226	Mar. 6	Mar. 6	Slight.	Sli't, earthy.	0.10	4.50	1.25	3.25	.0028	.0224 .0168	.51	.0200	.0003
4464	Apr. 3	Apr. 3	Very slight.	Slight.	0.20	4.65	1.25	3.40	.0060	.0278 .0194	.46	.0120	.0003
4615	May 6	May 6	Slight.	Con., floc't.	0.15	4.90	1.45	3.45	.0032	.0242 .0180	.49	.0080	.0006
Av.	....	....	....	....	0.14	5.04	1.21	3.83	.0033	.0241	.49	.0104	.0003

Hardness in May, 1888, 2.3. Odor, faintly vegetable, occasionally disagreeable.——The samples were collected from a faucet in the village, with the exception of Nos. 2746, 2866 and 3074, which were collected from the storage reservoir.

Microscopical Examination.

	1888. June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	1889. Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ, ...	5.0	0.1	pr.	0.0	0.1	pr.	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	44.4	4.1	0.3	1.3	pr.	0.1	0.4	1.3	4.0	160.1	11.8	0.4
3. Fungi, ...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, ...	pr.	62.0	0.2	1.6	pr.	pr.	pr.	pr.	4.6	0.2	0.1	0.1

Groups and principal genera of organisms observed: 1. Cyanophyceæ, *Chroococcus*, *Sphærozyga*. 2. Palmellaceæ, *Chlorococcus*; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Asterionella*, *Stephanodiscus*, *Synedra*. 3. Schizomycetes. 4. Protozoa, *Dinobryon*; Spongiaria; Nematoda; Rotifera; Entomostraca.

Chemical Examination of Water from Winter Pond in Winchester.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
935	Oct. 12	Oct. 13	Slight.	Sli't, white.	0.2	4.15	1.35	2.80	.0000	.0291	.45	.0070	–

The sample was collected from the pond at the surface of the water near the shore.

Water Supply of Winthrop.

This town is supplied jointly with Revere by the Revere Water Company. *See Revere, p. 281.*

Water Supply of Woburn.

Description of Works. — Population in 1885, 11,750. The works are owned by the city. Water was introduced Sept. 1, 1873. The average daily consumption for 1888 was 769,600 gallons. The source of supply is a filter-gallery on the southern shore of Horn Pond in Woburn. The filter-gallery is about 130 feet distant from the shore of the pond; it is 82 feet long and 12 feet wide inside, and is covered by a semicircular brick arch. The side walls are 9 feet high, and the bottom of the gallery is about 8 feet below high water in the pond. Pumps force the water from the gallery to the main pipe leading to the town, and to an open distributing reservoir on Horn Pond Mountain near the pond. The shape of the reservoir is irregular. The bottom and two sides are of ledge, and the remaining two sides are stone walls. Its maximum depth, when full, is 23 feet, and its capacity is 6,000,000 gallons. Distributing mains and service pipes are of wrought iron lined with cement. Enamelled iron was formerly used for service pipes. There have been frequent complaints of a taste and odor in the water supplied to consumers, usually during the summer months, at times when the pumps were not running and water was being drawn directly from the reservoir. This trouble is attributed to the growth of algæ in the reservoir. Horn Pond has an area of 103 acres. Its

watershed, of 4,760 acres, contains a large population and several tanneries and currying establishments. The pond is within the drainage area of Upper Mystic Lake, and consequently furnishes a portion of the supply of the Mystic Works of Boston.

Chemical Examination of Water from the Filter-Gallery of the Woburn Water Works.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
116	June 15	June 17	None.	None.	0.0	11.30	–	–	.0017	.0029	1.91	.0520	–
314	July 11	July 13	None.	None.	0.0	11.70	–	–	.0012	.0022	2.29	.0340	–
523	Aug. 11	Aug. 12	None.	None.	0.0	12.00	–	–	.0004	.0026	2.41	.0330	–
733	Sept. 12	Sept. 12	None.	None.	0.0	12.15	–	–	.0016	.0052	2.36	.0130	–
937	Oct. 12	Oct. 13	None.	None.	0.0	12.45	–	–	.0011	.0020	2.52	.0370	–
1142	Nov. 10	Nov. 10	None.	None.	0.0	12.10	–	–	.0012	.0020	2.60	.0230	–
1391	Dec. 13	Dec. 14	Very slight.	None.	0.0	12.75	–	–	.0023	.0029	2.69	.0280	–
	1888.												
1580	Jan. 11	Jan. 12	None.	None.	0.0	11.75	–	–	.0017	.0027	2.74	.0500	.0001
1784	Feb. 9	Feb. 9	None.	None.	0.0	12.25	–	–	.0032	.0032	2.61	.0250	.0000
1995	Mar. 12	Mar. 12	Very slight.	None.	0.0	11.80	–	–	.0000	.0048	2.57	.0450	.0000
2190	Apr. 11	Apr. 11	Distinct.	None.	0.0	11.55	–	–	.0010	.0028	2.43	.0450	.0001
2388	May 9	May 9	Very slight.	None.	0.0	11.65	–	–	.0002	.0048	2.41	.0300	.0001
2655	June 21	June 22	None.	None.	0.0	12.00	–	–	.0010	.0028	2.32	.0350	.0000
2753	July 10	July 11	None.	None.	0.0	12.00	–	–	.0014	.0028	2.39	.0380	.0000
2924	Aug. 13	Aug. 14	Very slight.	None.	0.0	12.70	–	–	.0010	.0030	2.51	.0120	.0001
3154	Sept. 11	Sept. 12	None.	None.	0.0	12.55	–	–	.0016	.0030	2.49	.0300	.0000
3338	Oct. 10	Oct. 10	None.	None.	0.0	12.30	–	–	.0016	.0018	2.62	.0350	.0000
3547	Nov. 14	Nov. 15	None.	None.	0.0	12.10	–	–	.0020	.0034	2.50	.0400	.0000
3690	Dec. 10	Dec. 11	Very slight.	None.	0.0	11.40	–	–	.0000	.0030	2.41	.0300	.0001
	1889.												
3837	Jan. 9	Jan. 10	None.	None.	0.0	11.45	–	–	.0012	.0024	2.19	.0550	.0000
4007	Feb. 11	Feb. 12	None.	None.	0.0	10.65	–	–	.0006	.0010	2.04	.0550	.0000
4274	Mar. 11	Mar. 12	None.	None.	0.0	10.75	–	–	.0002	.0022	2.12	.0300	.0001
4480	Apr. 8	Apr. 10	Very slight.	None.	0.0	10.65	–	–	.0000	.0040	2.05	.0400	.0001
4626	May 7	May 8	None.	None.	0.0	10.70	–	–	.0002	.0022	2.11	.0450	.0000
Av.	....	....	....	....	0.0	11.78	–	–	.0011	.0029	2.39	.0358	.0000

Hardness in May, 1888, 5.3. Odor, none, rarely vegetable.——The samples were collected from a faucet at the pumping station while pumping, or from the pump well.

Microscopical Examination.

	1888.								1889.				
	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ, . .	0.0	0.0	0.0	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	pr.	0.0	0.0	0.8	pr.	0.0	0.1	0.1	0.0	0.0	0.0	0.1	pr.
3. Fungi, ...	0.0	0.0	pr.	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, . . .	pr.	0.0	0.0	0.1	0.0	pr.	0.0	0.0	0.0	pr.	0.0	0.0	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Zoosporeæ; Diatomaceæ. 3. Schizomycetes. 4. Protozoa.

Chemical Examination of Water from the Distributing Reservoir of the Woburn Water Works.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1887.												
117	June 15	June 17	Very slight, milky.	None.	0.05	11.92	–	–	.0090	.0165	2.16	.0130	–
522	Aug. 10	Aug. 12	None.	None.	0.00	10.65	–	–	.0042	.0091	2.15	.0200	–
734	Sept. 12	Sept. 12	Slight.	Very slight.	0.00	10.90	–	–	.0008	.0109	2.18	.0070	–
938	Oct. 12	Oct. 13	Very slight.	Very slight.	0.00	12.05	–	–	.0010	.0108	2.29	.0130	–
1143	Nov. 10	Nov. 10	Very slight.	Slight.	0.00	13.10	–	–	.0001	.0056	2.57	.0250	–
1392	Dec. 13	Dec. 14	Very slight.	Very slight.	0.05	12.75	–	–	.0004	.0076	2.61	.0250	–
	1888.												
1579	Jan. 11	Jan. 12	Very slight.	Very slight.	0.00	12.40	–	–	.0000	.0054	2.80	.0400	.0001
1783	Feb. 8	Feb. 9	Very slight.	Very slight, white.	0.00	11.90	–	–	.0000	.0054	2.66	.0350	.0001
1994	Mar. 12	Mar. 12	Very slight.	Slight.	0.10	12.15	–	–	.0000	.0080	2.66	.0350	.0002
2199	Apr. 12	Apr. 12	Distinct.	Very slight.	0.05	11.90	–	–	.0000	.0060	2.44	.0400	.0003
2389	May 9	May 9	Distinct.	None.	0.00	12.10	–	–	.0002	.0118	2.37	.0250	.0005
2654	June 21	June 22	None.	None.	0.00	11.45	–	–	.0018	.0104 .0098	2.32	.0200	.0007
2754	July 10	July 11	None.	None.	0.00	12.15	–	–	.0076	.0076	2.39	.0350	.0002
2925	Aug. 13	Aug. 14	Slight.	None.	0.00	11.70	–	–	.0024	.0070 .0068	2.34	.0080	.0004
3155	Sept. 11	Sept. 12	Very slight.	Very slight.	0.00	10.95	–	–	.0024	.0132	2.23	.0050	.0001
3337	Oct. 10	Oct. 10	Very slight.	Very slight.	0.00	11.65	–	–	.0000	.0098 .0028	2.50	.0300	.0001
3548	Nov. 14	Nov. 15	Slight.	Very slight.	0.00	11.75	–	–	.0000	.0092 .0040	2.50	.0250	.0001
3691	Dec. 10	Dec. 11	Very slight.	Slight.	0.00	10.95	–	–	.0002	.0050 .0028	2.38	.0280	.0003

Chemical Examination of Water from the Distributing Reservoir of the Woburn Water Works — Concluded.

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.		Nitrates.	Nitrites.
	1889.												
3838	Jan. 9	Jan. 10	Distinct.	Very slight.	0.00	10.75	–	–	.0002	.0080 .0036	2.13	.0500	.0003
4008	Feb. 11	Feb. 12	Slight.	Slight.	0.00	10.35	–	–	.0000	.0074 .0028	2.10	.0600	.0002
4275	Mar. 11	Mar. 12	Very slight.	Very slight.	0.00	11.45 10.65	–	–	.0002	.0068 .0018	2.10	.0400	.0004
4481	Apr. 8	Apr. 10	Very slight.	Very slight.	0.00	10.95	–	–	.0000	.0086 .0038	2.10	.0350	.0005
4627	May 7	May 8	Very slight.	None.	0.00	10.80	–	–	.0008	.0084 .0068	2.08	.0250	.0010
Av.	....	....	....	....	0.01	11.73	–	–	.0014	.0086	2.35	.0278	.0003

Hardness in May, 1888, 5.3. Odor, generally none, occasionally disagreeable.—The samples were collected from the distributing reservoir at the surface. The reservoir was emptied and cleaned July 11, 1887, and exposed to the sun and air for one week before it was refilled. On the 5th and 6th of July, 1888, the reservoir was again drawn off and cleaned. It was again drawn off on Sept. 14, 1888.

Microscopical Examination.

	1888.							1889.				
	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ, ...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	pr.	10.9	1.5	0.3	75.2	35.0	25.1	23.0	4.8	7.0	6.0	0.6
3. Fungi, ...	0.0	0.2	pr.	pr.	0.0	0.0	0.0	0.0	0.0	0.5	6.0	0.0
4. Animal Forms, ...	0.0	1.0	pr.	pr.	7.2	4.0	8.0	30.0	4.2	0.0	0.3	0.8

Groups and principal genera of organisms observed: 2. Palmellaceæ; Zoosporeæ, *Scenedesmus;* Diatomaceæ, *Asterionella, Synedra;* Zygnemaceæ. 3. Schizomycetes, *Spirillum.* 4. Protozoa, *Peridinium, Trachelomonas;* Entomostraca.

Chemical Examination of Water from Horn Pond in Woburn.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.		Nitrates.	Nitrites.
	1887												
118	June 15	June 17	Decided.	Con., white.	0.50	10.10	2.15	7.95	.0066	.0415	2.50	.0350	–
313	July 11	July 13	Decided.	Con., brown.	0.40	12.74	2.17	10.57	.0042	.0303	2.94	.0030	–

Chemical Examination of Water from Horn Pond in Woburn — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
521	Aug. 11	Aug. 12	Decided.	Consid'ble.	0.70	13.70	3.25	10.45	.0010	.0643	3.63	.0000	–
732	Sept. 12	Sept. 12	Slight.	Slight.	0.45	14.40	1.70	12.70	.0086	.0445	3.76	.0130	–
936	Oct. 12	Oct. 13	Slight.	Consid'ble.	0.40	14.50	1.65	12.85	.0081	.0455	4.02	.0260	–
1141	Nov. 10	Nov. 10	Slight.	Con., white.	0.35	15.30	2.40	12.90	.0434	.0375	4.58	.0300	–
1390	Dec. 13	Dec. 14	Distinct.	Con., white.	0.30	15.80	2.00	13.80	.0322	.0224	4.73	.0500	–
	1888.												
1578	Jan. 11	Jan. 12	Distinct.	Slight.	0.40	11.00	1.10	9.90	.0321	.0323	2.87	.0750	.0008
1782	Feb. 9	Feb. 9	Slight.	Sli't, white.	0.30	14.15	2.40	11.75	.0377	.0408	4.10	.0800	.0020
1993	Mar. 12	Mar. 12	Slight.	Slight.	0.40	13.00	2.50	10.50	.0355	.0304	3.32	.0800	.0020
2189	Apr. 11	Apr. 11	Decided.	Slight.	0.50	10.65	1.60	9.05	.0445	.0279	2.61	.0400	.0039
2387	May 9	May 9	Decided.	Sli't, green.	0.35	10.05	2.05	8.00	.0034	.0372	2.28	.0450	.0020
2653	June 21	June 23	Decided.	Consid'ble.	0.35	9.85	1.45	8.40	.0002	.0698 .0290	2.34	.0120	.0016
2752	July 10	July 11	Distinct.	Slight.	0.25	9.90	1.50	8.40	.0226	.0446 .0324	2.74	.0070	.0007
2923	Aug. 13	Aug. 14	Distinct.	Con., green.	0.10	12.10	1.40	10.70	.0012	.0370 .0240	3.52	.0030	.0000
3153	Sept. 11	Sept. 12	Distinct.	Consid'ble.	0.20	12.50	1.35	11.15	.0062	.0400 .0244	3.82	.0050	.0003
3336	Oct. 10	Oct. 10	Distinct.	Con., green.	0.20	11.90	1.75	10.15	.0114	.0372 .0224	3.30	.0300	.0013
3546	Nov. 14	Nov. 15	Slight.	Con., green.	0.50	11.50	1.70	9.80	.0154	.0396 .0250	2.99	.0500	.0016
3689	Dec. 10	Dec. 11	Distinct.	Slight.	0.30	8.80	1.75	7.05	.0132	.0226 .0194	1.88	.0500	.0012
	1889.												
3836	Jan. 9	Jan. 10	Distinct.	Slight.	0.30	8.10	2.10	6.00	.0156	.0204 .0154	1.41	.1000	.0011
4006	Feb. 11	Feb. 12	Distinct.	Con., light.	0.20	7.70	1.45	6.25	.0088	.0268 .0168	1.39	.1000	.0012
4273	Mar. 11	Mar. 12	Distinct.	Con., light green.	0.30	8.75	2.45	6.30	.0052	.0266 .0140	1.73	.1000	.0025
4479	Apr. 8	Apr. 10	Decided.	Heavy, green.	0.10	8.55	1.85	6.70	.0040	.0308 .0158	1.85	.0900	.0024
4625	May 7	May 8	Distinct.	Con., light colored.	0.20	8.75	2.30	6.45	.0036	.0344 .0222	1.90	.0600	.0017
Av.	....	....	....	....	0.34	12.95	2.08	10.87	.0152	.0389	2.93	.0452	.0015

Hardness in July, 1887, 5.6; in May, 1888, 3.1. Odor, vegetable and grassy, frequently mouldy. — The samples were collected from the pond near the pumping station of the Woburn Water Works, about 200 feet from shore and from 1 to 4 feet beneath the surface; excepting Nos. 1390, 1578, 2189, 2387, 3689, 3836, 4006, 4273, 4479 and 4625, which were collected about 20 feet from shore.

Microscopical Examination.

	1888.							1889.				
	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ,	pr.	pr.	0.4	0.2	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.2
2. Other Algæ,	6.2	35.3	85.4	38.4	29.7	39.7	1.9	9.1	70.5	1360.7	6515.6	386.3
3. Fungi,	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms,	pr.	pr.	0.4	4.0	3.0	8.0	1.2	7.0	0.3	6.0	pr.	1.6

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ, *Chlorococcus;* Zoosporeæ, *Scenedesmus;* Desmidiaceæ, *Cosmarium;* Diatomaceæ, *Asterionella, Fragillaria, Melosira, Stephanodiscus, Synedra, Tabellaria;* Volvocineæ. 3. Schizomycetes. 4. Protozoa, *Trachelomonas;* Rotifera; Entomostraca. Nearly all of the very large number of organisms found in March and April, 1889, were of the genus *Asterionella.*

Table showing Heights of Water in Horn Pond at Times when Samples of Water were collected for Analysis.

NOTE: Heights are in feet above the bottom of the pump well at the pumping station.

DATE.	Height of Water.	DATE.	Height of Water.
1887.		**1888.**	
November 10,	8.40	September 11,	8.19
December 13,	8.50	October 10,	8.72
1888.		November 14,	8.71
January 11,	8.60	December 10,	9.08
February 9,	8.60	**1889.**	
March 12,	8.55	January 9,	8.85
April 11,	9.02	February 11,	8.55
May 9,	8.52	March 11,	8.65
June 21,	8.33	April 8,	8.58
July 10,	8.18	May 7,	8.50
August 13,	8.06		

Water Supply of Worcester.

Description of Works.—Population in 1885, 68,389. The works are owned by the city. Water was introduced in 1845. The estimated average daily consumption in 1888 was 4,634,925 gallons. The present sources of supply are Lynde Brook in Leicester and Tatnuck Brook in Holden. On each of these brooks a storage reservoir is built.

Lynde Brook storage reservoir was built in 1864. The dam was raised in 1870 and 1871, and was carried away in March, 1876. The present dam was then constructed. The area of the reservoir is 143 acres, and its capacity is 681,000,000 gallons. Portions of the bottom are muddy. The maximum depth of the reservoir is 37.4 feet, and its average depth 14.6 feet. The shores are generally steep. Water flows by gravity from the storage reservoir to the Hunt distributing reservoir, located within the city limits. This reservoir is rectangular in shape, and its capacity is about 3,000,000 gallons. The bottom and slopes are paved. Water entering the reservoir is aerated by being discharged from a vertical pipe having its top 12 feet above the water in the reservoir.

Tatnuck Brook storage reservoir was built in 1883. The area of the reservoir is 94.5 acres, and its capacity is 450,000,000 gallons. Portions of the bottom are muddy. Its average depth is 14.6 feet. The shores of this reservoir are abrupt, with the exception of a small portion at the upper end. Water flows from the storage to a distributing reservoir, also situated on Tatnuck Brook, about one mile further down stream and 80 feet lower than the storage reservoir. The distributing reservoir is irregular in shape, and its capacity is about 2,500,000 gallons. The slopes and bottom are paved.

The area of the watershed of Leicester storage reservoir is 1,870 acres; that of Holden storage reservoir is 2,915 acres. These areas are of the same general character. The country in the region of the reservoirs is very hilly, and about one-half of each area is covered with wood, the remainder being devoted to pasturage and cultivation. The soil is generally of clay or rock. There is a small agricultural population on each area.

Bell Pond, in the eastern part of the city, is used as a distributing reservoir, and is generally filled from the Leicester supply, though it has a small watershed which supplies a portion of the water used from it. Water is distributed by gravity. The original distributing mains were of wrought iron lined with cement. Cast iron has been used for many years, and at present about three-fifths of the distributing mains are of cast iron. Service pipes are generally of wrought iron lined with cement.

LEICESTER SUPPLY. — *Chemical Examination of Water from the Lynde Brook Storage Reservoir.*

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1887.												
146	June 20	June 21	Slight.	None.	0.05	2.92	0.87	2.05	.0001	.0131	.14	.0000	–
629	Aug. 25	Aug. 27	Very slight.	Very slight.	0.40	3.20	1.30	1.90	.0036	.0189	.11	.0030	–
796	Sept. 15	Sept. 16	Decided.	Very slight.	0.15	2.90	0.55	2.35	.0014	.0184	.14	.0030	–
988	Oct. 19	Oct. 20	Slight.	Sli't, brown.	0.35	3.25	0.75	2.50	.0092	.0224	.15	.0070	–
1216	Nov. 17	Nov. 18	Distinct.	Sli't, earthy and floc't.	0.50	3.30	1.20	2.10	.0112	.0238	.16	.0060	–
1456	Dec. 20	Dec. 22	Slight.	Slight.	0.35	3.35	1.00	2.35	.0088	.0195	.17	.0070	.0000
	1888.												
1628	Jan. 18	Jan. 20	Very slight.	Very slight.	0.30	3.05	0.85	2.20	.0073	.0096	.11	.0040	–
1820	Feb. 13	Feb. 15	Slight.	Sli't, white.	0.30	3.00	1.10	1.90	.0070	.0155	.16	.0100	.0000
2077	Mar. 20	Mar. 22	Slight.	Very slight.	0.30	3.15	1.10	2.05	.0051	.0120	.15	.0100	.0001
2192	Apr. 10	Apr. 12	Slight.	Very slight.	0.20	2.50	0.70	1.80	.0014	.0153	.15	.0100	–
2383	May 8	May 9	Slight.	None.	0.15	2.20	0.60	1.60	.0002	.0108	.14	.0080	.0000
2649	June 21	June 22	Very slight.	Sli't, white.	0.20	2.30	0.85	1.45	.0016	.0188 .0162	.14	.0050	.0001
2759	July 11	July 12	Very slight.	Sli't, white.	0.20	2.35	0.85	1.50	.0008	.0148	.14	.0030	.0001
2927	Aug. 13	Aug. 14	Slight.	Sli't, brown.	0.15	2.45	0.80	1.65	.0008	.0152 .0128	.17	.0050	.0001
3151	Sept. 10	Sept. 12	Very slight.	Slight.	0.20	2.50	0.90	1.60	.0018	.0174 .0160	.14	.0050	.0002
3333	Oct. 9	Oct. 10	Slight.	Sli't, green.	0.20	2.40	0.90	1.50	.0094	.0174 .0150	.12	.0040	.0003
3534	Nov. 12	Nov. 14	Distinct.	Slight.	0.40	2.75	0.85	1.90	.0054	.0162 .0144	.14	.0060	.0002
3693	Dec. 10	Dec. 11	Slight.	Very slight.	0.25	3.00	0.70	2.30	.0040	.0180 .0168	.17	.0080	.0003
	1889.												
3849	Jan. 14	Jan. 16	Distinct.	Coarse, dark brown.	0.30	2.65	0.45	2.20	.0038	.0176 .0134	.15	.0070	.0005
4044	Feb. 19	Feb. 20	Very slight.	Slight.	0.15	2.65	0.55	2.10	.0036	.0098 .0090	.14	.0060	.0002
4335	Mar. 18	Mar. 19	Very slight.	Very slight.	0.25	2.65	0.75	1.90	.0020	.0162 .0138	.13	.0120	.0001
4515	Apr. 15	Apr. 16	Distinct.	Sli't, white.	0.30	2.40	0.70	1.70	.0008	.0178 .0152	.14	.0080	.0001
4669	May 14	May 16	Very slight.	Slight.	0.20	2.35	0.55	1.80	.0030	.0142 .0128	.13	.0060	.0001
Av.	....	....	....	....	0.25	2.98	0.91	2.07	.0040	.0162	.14	.0062	.0001

Hardness in May, 1888, 0.5. Odor, faintly vegetable and grassy, sometimes none. —— The samples were collected from the reservoir one foot beneath the surface, with the exception of Nos. 3534, 3693 and 3849, which were collected at the foot of the overflow below the dam.

Microscopical Examination.

	1888.							1889.				
	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ,	0.2	pr.	0.2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2 Other Algæ,	0.3	0.5	0.6	4.8	0.6	0.5	1.6	pr.	pr.	0.1	pr.	pr.
3. Fungi,	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms,	0.0	0.8	pr.	0.0	7.7	0.1	pr.	pr.	pr.	1.2	1.2	pr.

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ, *Chlorococcus;* Zoosporeæ, *Tetraspora;* Desmidiaceæ; Diatomaceæ, *Asterionella.* 4. Protozoa, *Dinobryon;* Rotifera; Entomostraca.

LEICESTER SUPPLY.— *Chemical Examination of Water from the Hunt Distributing Reservoir, Worcester.*

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance: Turbidity.	Appearance: Sediment.	Appearance: Color.	Residue on Evaporation: Total.	Residue on Evaporation: Loss on Ignition.	Residue on Evaporation: Fixed.	Ammonia: Free.	Ammonia: Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
145	June 20	June 21	Very slight.	None.	0.05	2.62	0.85	1.77	.0000	.0116	.15	.0130	–
630	Aug. 25	Aug. 27	Very slight.	None.	0.40	2.92	1.42	1.50	.0019	.0164	.10	.0070	–
795	Sept. 15	Sept. 16	Very slight.	Very slight.	0.10	2.90	0.80	2.10	.0014	.0182	.20	.0030	–
989	Oct. 19	Oct. 20	Distinct.	Slight.	0.40	2.95	0.75	2.20	.0064	.0200	.14	.0080	–
1217	Nov. 17	Nov. 18	Slight.	Slight.	0.50	3.10	1.10	2.00	.0096	.0226	.15	.0060	–
1457	Dec. 20	Dec. 22	Slight.	Very slight.	0.20	3.05	1.00	2.05	.0078	.0185	.16	.0080	.0000
	1888.												
1629	Jan. 18	Jan. 20	Very slight.	Very slight.	0.25	2.90	0.85	2.05	.0064	.0120	.09	.0090	–
1821	Feb. 13	Feb. 15	Very slight.	Sli't, earthy and floc't.	0.30	3.10	1.10	2.00	.0065	.0135	.18	.0150	.0000
2078	Mar. 20	Mar. 22	Distinct, milky.	Very slight.	0.20	2.95	1.00	1.95	.0041	.0179	.17	.0070	.0001
2193	Apr. 10	Apr. 12	Slight.	Slight.	0.20	2.60	0.60	2.00	.0046	.0148	.17	.0100	.0002
2384	May 8	May 9	Slight.	Very slight.	0.20	2.55	0.80	1.75	.0014	.0120	.13	.0010	.0001
Av.	....	....	....	....	0.25	2.88	0.93	1.95	.0046	.0161	.15	.0079	.0001

Hardness in May, 1888, 0.6. Odor, faintly vegetable.—— The samples were collected from the reservoir near the gate house at about one foot beneath the surface.

Microscopical Examination.

	1888.		
	March.	April.	May.
1. Blue-green Algæ,	0.0	0.0	pr.
2. Other Algæ,	pr.	pr.	pr.
3. Fungi,	0.0	0.0	0.0
4. Animal Forms,	pr.	pr.	pr.

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ. 4. Protozoa.

HOLDEN SUPPLY.— *Chemical Examination of Water from Tatnuck Brook Storage Reservoir.*

[Parts per 100,000.]

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.	Chlorine.	Nitrates.	Nitrites.
	1887.												
144	June 20	June 21	Slight.	None.	0.05	2.27	1.07	1.20	.0002	.0148	.14	–	–
627	Aug. 25	Aug. 27	Distinct.	Sli't, brown.	0.60	3.07	1.62	1.45	.0019	.0220	.08	.0030	–
794	Sept. 15	Sept. 16	Decided.	Sli't, earthy.	0.20	2.50	0.90	1.60	.0000	.0188	.15	.0000	–
990	Oct. 19	Oct. 20	Decided.	Con., brown.	0.40	2.65	0.75	1.90	.0000	.0236	.13	.0030	–
1218	Nov. 17	Nov. 18	Distinct.	Con., e'rthy and floc't.	0.30	2.60	0.95	1.65	.0012	.0218	.15	.0000	–
1458	Dec. 20	Dec. 22	Distinct.	Sl't, earthy.	0.20	2.65	0.75	1.90	.0006	.0170	.16	.0020	.0000
	1888.												
1630	Jan. 18	Jan. 20	Very slight.	None.	0.10	2.20	0.70	1.50	.0005	.0100	.08	.0030	–
1822	Feb. 13	Feb. 15	Very slight.	Very slight, white.	0.20	2.50	0.75	1.75	.0046	.0120	.16	.0100	.0000
2079	Mar. 20	Mar. 22	Very slight.	None.	0.20	2.25	0.60	1.65	.0053	.0077	.13	.0060	.0000
2191	Apr. 10	Apr. 12	Slight.	Very slight.	0.20	1.75	0.50	1.25	.0003	.0095	.11	.0040	.0001
2385	May 8	May 9	Distinct.	Slight.	0.15	2.25	0.90	1.35	.0010	.0198	.11	.0000	.0001
2648	June 21	June 22	Slight.	Sli't, white.	0.10	1.80	0.80	1.00	.0002	.0202 .0142	.10	.0050	.0000
2758	July 11	July 12	Distinct.	Con., white.	0.20	3.30	0.75	2.55	.0004	.0180 .0158	.10	.0020	.0001
2926	Aug. 13	Aug. 14	Distinct.	Sli't, brown.	0.15	1.90	0.75	1.15	.0004	.0164 .0112	.14	.0030	.0000
3152	Sept. 10	Sept. 12	Slight.	Consid'ble.	0.20	2.10	0.75	1.35	.0012	.0226 .0172	.11	.0070	.0001

Holden Supply. — *Chemical Examination of Water from Tatnuck Brook Storage Reservoir* — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
3332	Oct. 9	Oct. 10	Distinct.	Sli't, green.	0.10	2.10	0.95	1.15	.0000	.0228 .0134	.10	.0030	.0002
3533	Nov. 12	Nov. 14	Slight.	Sli't, e'rthy.	0.30	2.25	0.80	1.45	.0000	.0174 .0120	.14	.0050	.0002
3694	Dec. 10	Dec. 11	Slight.	Consid'ble.	0.10	2.30	0.80	1.50	.0000	.0114 .0076	.15	.0030	.0004
	1889.												
3848	Jan. 14	Jan. 16	Slight.	Slight.	0.15	1.85	0.50	1.35	.0010	.0090 .0066	.12	.0050	.0002
4045	Feb. 19	Feb. 20	Veryslight.	Veryslight.	0.20	2.25	0.65	1.60	.0000	.0056 .0044	.15	.0050	.0001
4334	Mar. 18	Mar. 19	Veryslight.	Veryslight.	0.20	2.10	0.60	1.50	.0008	.0106 .0088	.10	.0090	.0001
4516	Apr. 15	Apr. 16	Slight.	Slight.	0.05	1.90	0.50	1.40	.0000	.0112 .0092	.09	.0030	.0001
4670	May 14	May 16	Slight.	Consid'ble.	0.10	2.10	0.60	1.50	.0002	.0144 .0098	.11	.0030	.0001
Av.	....	....	....	....	0.19	2.43	0.86	1.57	.0009	.0155	.12	.0038	.0001

Hardness in May, 1888, 0.3. Odor, faintly vegetable, rarely mouldy and disagreeable. —— Samples 144, 990, 1218, 1822, 2079 and 2191 were collected from the 30-inch pipe where it discharges into the brook below the reservoir. Nos. 2385, 2648, 2758, 2926, 3152 and 4334 were collected from the reservoir in front of the gate-house one foot beneath the surface. The remaining samples were collected from the foot of the overflow 200 feet below the dam.

Microscopical Examination.

	1888. June.	1888. July.	1888. Aug.	1888. Sept.	1888. Oct.	1888. Nov.	1888. Dec.	1889. Jan.	1889. Feb.	1889. Mar.	1889. Apr.	1889. May.
1. Blue-green Algæ, ...	pr.	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	3.5	45.7	8.2	94.2	54.8	53.0	0.7	3.0	0.3	1.6	0.4	2.0
3. Fungi, ...	0.1	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, ...	0.4	1.2	1.1	6.2	1.4	2.0	0.0	2.0	2.5	100.1	0.1	0.2

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ, *Chlorococcus;* Zoosporeæ, *Pediastrum*, *Scenedesmus;* Desmidiaceæ, *Sphærozosma*, *Staurastrum;* Diatomaceæ, *Asterionella*, *Melosira*, *Nitzchia*, *Tabellaria*. 3. Schizomycetes. 4. Protozoa, *Difflugia*, *Dinobryon;* Rotifera; Entomostraca.

HOLDEN SUPPLY.— *Chemical Examination of Water from Tatnuck Brook Distributing Reservoir.*

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
143	June 20	June 21	Slight.	None.	0.10	2.72	0.85	1.87	.0001	.0134	.17	.0000	-
628	Aug. 25	Aug. 27	Distinct.	Slight.	0.60	3.17	1.27	1.90	.0023	.0189	.08	.0030	-
793	Sept. 15	Sept. 16	Decided.	Sli't, earthy.	0.10	2.70	0.70	2.00	.0010	.0170	.16	.0000	-
991	Oct. 19	Oct. 20	Distinct.	Slight.	0.40	2.55	0.90	1.65	.0000	.0200	.13	.0030	-
1219	Nov. 17	Nov. 18	Slight.	Sli't, earthy and floc't.	0.30	2.60	0.80	1.80	.0010	.0206	.17	.0030	-
1459	Dec. 20	Dec. 22	Distinct.	Sli't, earthy.	0.15	2.80	0.80	2.00	.0010	.0186	.15	.0060	.0000
	1888.												
1631	Jan. 18	Jan. 20	Very slight.	Very slight.	0.20	2.40	0.85	1.55	.0004	.0084	.09	.0150	-
1823	Feb. 13	Feb. 15	Very slight.	Slight.	0.20	2.45	0.75	1.70	.0035	.0104	.17	.0080	.0000
2080	Mar. 20	Mar. 22	Very slight.	Sli't, brown.	0.20	2.65	0.60	2.05	.0061	.0101	.14	.0090	.0000
2194	Apr. 10	Apr. 12	Slight.	Very slight.	0.10	2.00	0.45	1.55	.0004	.0084	.12	.0050	.0002
2386	May 8	May 9	Slight.	Slight.	0.15	2.55	1.00	1.55	.0016	.0148	.13	.0030	.0000
Av.	....	....	....	....	0.23	2.60	0.82	1.78	.0016	.0146	.14	.0050	-

Hardness in May, 1888, 0.3. Odor, very faintly vegetable.—— The samples were collected from the reservoir near the surface.

Microscopical Examination.

	1888. March.	1888. April.	1888. May.
1. Blue-green Algæ,	0.0	0.0	pr.
2. Other Algæ,	pr.	pr.	pr.
3. Fungi,	0.0	0.0	0.0
4. Animal Forms,	0.0	pr.	pr.

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Zoosporeæ; Diatomaceæ. 4. Protozoa.

Chemical Examination of Water from Bell Pond, Worcester.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
792	Sept. 15	Sept. 16	Decided.	Sli't, e'rthy.	0.05	2.65	0.60	2.05	.0008	.0232	.22	.0000	–
	1888.												
2081	Mar. 20	Mar. 22	Distinct.	Sli't, brown.	0.20	2.85	0.80	2.05	.0087	.0165	.24	.0050	.0000

Odor, very faintly vegetable.——The samples were collected from the pond in front of the gate-house.

Microscopical Examination.

March, 1888. 1. Blue-green algæ, 0.0; 2. Other algæ, pr.; 3. Fungi, 0.0; 4. Animal forms, pr. Groups and principal genera of organisms observed: 2. Palmellaceæ. 4. Protozoa.

Record of Heights of Water in Holden and Leicester Storage Reservoirs at Times when Samples of Water were Collected for Analysis.

NOTE.—Holden Reservoir, height of rollway, 20.10 feet; Leicester Reservoir, height of rollway, 37.40 feet.

Date.	Height of Water. Holden.	Height of Water. Leicester.	Date.	Height of Water. Holden.	Height of Water. Leicester.
1887.			**1888.**		
June 20,	19.64	37.02	July 11,	19.31	35.64
August 25,	20.98	38.15	August 13,	17.38	33.68
September 15,	20.22	37.35	September 10,	16.07	32.98
October 19,	19.60	36.41	October 9,	20.38	36.20
November 17,	18.62	36.36	November 12,	20.28	37.82
December 20,	20.20	37.33	December 10,	20.24	37.55
1888.			**1889.**		
January 18,	20.32	37.54	January 14,	20.44	35.55
February 13,	17.35	37.43	February 19,	20.00	37.15
March 20,	14.50	34.68	March 18,	15.70	37.62
April 10,	20.21	37.02	April 15,	20.09	37.50
May 8,	20.17	37.53	May 14,	20.08	37.30
June 21,	20.07	36.85			

EXAMINATIONS OF WATER SUPPLIES AND RIVERS.

RIVERS.

DESCRIPTIONS OF THE RIVER BASINS; CHEMICAL AND BIOLOGICAL EXAMINATIONS OF THE WATERS.

RIVERS.

DESCRIPTIONS OF THE RIVER BASINS; CHEMICAL AND BIOLOGICAL EXAMINATIONS OF THE WATERS.

EXPLANATORY NOTE.

In the following tabulations the main river basins of the State are arranged in alphabetical order, and the subordinate basins are grouped with the main basin to which they belong. An exception to this rule is made in the case of the Merrimack and Connecticut rivers, whose affluents within the State are not grouped with them, but are treated as main river basins. The areas of the watersheds of the rivers within the State have been measured in nearly all cases from the topographical map made from the recent survey of the State. Exceptions to this rule will be noticed where they occur.

The populations on the watersheds in Massachusetts are based upon the State Census of 1885; in other States upon the United States Census of 1880. Where a town is in two or more watersheds its total population has been divided among them in proportion to the number of houses in each, as counted from the latest atlases.

The amount of rainfall has been above the average during the years covered by these investigations (June, 1887, to May, 1889, inclusive), and the flow of the streams has been correspondingly high, so that the analyses do not represent the polluted streams in their worst condition.

The tables of chemical and microscopical examinations of the waters are similar in all respects to those already given under the head of "Water Supplies" and explained on pp. 3-5 of this report.

RIVERS.

DESCRIPTIONS OF THE RIVER BASINS; CHEMICAL AND BIOLOGICAL EXAMINATIONS OF THE WATERS.

Blackstone River.

The Blackstone River is formed by the confluence of Kettle and Mill brooks at Quinsigamond Village in the southerly part of the city of Worcester, and flows thence in a generally south-easterly direction to tide water at Pawtucket, Rhode Island, crossing the State line at Blackstone. The drainage area of the river at Blackstone — not including Mill River, a tributary which unites with it below the State line — is 260 square miles.

The Blackstone Valley contained naturally a large number of lakes and ponds. In order to supply water for power to the mills, which occupy nearly every available site in the valley, many of these natural bodies of water have been raised, and, in addition, many large artificial storage reservoirs have been built. This very complete development of the water power in this valley acts in two ways as regards the pollution of the river. The mills discharge into the stream a large amount of manufacturing sewage, while on the other hand the dry weather flow of the stream is kept unusually high by the large amount of water stored. The land in the valley is generally hilly and rolling and not very well wooded. There are very few areas of swamp or other low lands subject to inundation.

The city of Worcester has a water supply from the head waters of tributaries of the Blackstone River, and a system of sewerage with an aggregate of 71 miles of sewers, which discharges sewage into the river chiefly through Mill Brook just below the village of Quinsigamond. Three of the towns in the valley, Grafton, Uxbridge and Northbridge, have public water supplies, but none of these places has at present a system of sewerage; consequently the pollution

from domestic sewage is very much less in proportion to the population outside of Worcester than in it.

The main source of pollution is the sewage of the city of Worcester, which had in 1888 an estimated population of 76,500. From the point where this sewage is discharged to the State line, a distance of about 26 miles, the river falls approximately 220 feet. The more recent examinations of the Board have been confined to this portion of the river.

Examinations of samples of water collected at three points have been made monthly since June, 1887, and records of the flow of water at four points were kept from September, 1887, to December, 1888; tables giving the results are appended. The statistics regarding the size of the drainage area at each of those points and of the population above the points where samples of water were collected for analysis are given in the following table; also, the distance to each of these places from the point where the sewage of Worcester is discharged into the river.

LOCALITY.	Distance below Point of Discharge of Worcester Sewage.	Drainage Area.	Estimated Population (1888).	Population per Square Mile.
	Miles.	Sq. Miles.		
1. At the Quinsigamond Iron and Wire Works,*	0	63.0	–	–
2. At the first bridge below Quinsigamond Village,†	1	63.9	77,500	1,213
3. At the dam of the Cordis Manuf'g Co., Millbury,*	5	77.9	–	–
4. At the upper dam of the Calumet Woolen Co., Uxbridge,* †	17	145.9	90,900	623
5. At the dam at Millville, Blackstone,†	24	258.1	102,800	398
6. At the dam of the Blackstone Manuf'g Co., Blackstone,*	26	260.3	–	–

* Points at which measurements of the flow of the river were made.
† Points at which samples of water were collected.

It will be seen from this table that the population is much more dense in the upper part of the valley than in the valley as a whole.

A careful examination of this river basin was made by the State Board of Health in 1875, and a list was prepared of all the mills and factories in the valley, which may be found in the report of the Board for 1876, pp. 74–81. A summary of the results is given in the following table taken from p. 82 of the same report.

MANUFACTURES.	Number.	Operatives employed.
Woolen mills,	44	3,003
Cotton mills,	27	3,978
Iron works,	12	1,224
Tanneries,	1	6
Shambles,	1	5
Totals,	85	8,216

NOTE.—Saw and grist mills are not considered polluting.

A further examination of this valley was made by the Massachusetts Drainage Commission in 1885.*

In choosing the places for collecting samples of water for analysis, care was taken in each case to select a point a considerable distance below any source of pollution, so that the polluting substances entering the river might be uniformly mixed with the water. The first point selected is in Worcester nearly a mile below the mouth of Mill Brook. It represents the portion of the river where the dilution of the sewage is least. The second place for collecting samples, at the Calumet Woolen Mill in Uxbridge, is 16 miles below the first point. In this distance the water passes through twelve mill ponds and falls a total distance of about 170 feet. The drainage area at the lower point is 128 per cent. greater than at the upper point, and the flow of the stream increases in about the same proportion. On the other hand the population at the lower point is only 18 per cent. greater than at the upper one. It is therefore obvious that the river water will become rapidly purer going down stream, on account of the great dilution, independent of any purification of the water which may result from other causes. On the river and its tributaries between these points there were, in 1885, 30 mills (including 9 woolen mills) employing 2,540 operatives.

At Millville, the lowest point on the river where samples are taken, the drainage area is four times as great as at the first point, and the population is but 34 per cent. greater. The distance between the second and third points is about 7 miles. The number of mills upon this portion of the river in 1885 was 14, including 5 woolen mills, and the number of operatives employed was 2,986.

* Report of a Commission appointed to consider a General System of Drainage for the Valleys of the Mystic, Blackstone and Charles rivers, pp. 95-110.

The Blackstone is, at the present time, the most polluted river in Massachusetts; a result which is due for the most part, as already stated, to the sewage of the city of Worcester, though the pollution is increased to an appreciable extent by the sewage and waste discharged into the stream from the many factories upon it and its tributaries.

The most polluted portion of the river is within a few miles of and below the point where the Worcester sewage enters it, and particularly in the town of Millbury, where there are several mill ponds which act as settling basins to retain foul deposits. In this portion of the river, and for a considerable distance below Millbury, the water is not only very offensive at times of low flow, but it is stated that it is so dirty that it cannot be used for making light-colored cloths, and is unfit for use in boilers, as it causes foaming and corrosion. The latter may be due in part to the large amount of acid used by the iron manufacturers in Worcester, some of which finds its way into the river, the water of which has at times, below Worcester, an acid reaction.

Analyses made at Uxbridge, 17 miles below the outlet of Worcester sewage, show a marked improvement in the quality of the river water, due largely to dilution by purer water from the tributaries. The water at this point is still highly polluted, but is not generally offensive to those living near its banks. At Millville, above the dam, the analyses show that the river water is still polluted, but the water at this place is entirely inoffensive. As above, this improvement in its quality is due largely to dilution, but it is also due in part to the chemical changes which have taken place in the water during its flow down the river. This feature will receive further discussion in a subsequent portion of this report.

The city of Worcester is now constructing works which will soon be in operation to clarify its sewage by chemical precipitation before discharging it into the river.

In addition to the tables of analyses of the water of the river at three points given below, examinations of other surface waters in the basin have been made, and are given in the preceding portion of this report as follows: —

Leicester, Kettle Brook in Paxton, ... page 185
Millbury, Singletary Pond, ... page 229
Worcester, Lynde Brook Storage Reservoir, . . . page 373
Worcester, Tatnuck Brook Storage Reservoir, . . page 375

Chemical Examination of Water from the Blackstone River below Quinsigamond Village, Worcester.

[Parts per 100,000.]

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.	Chlorine.	Nitrates.	Nitrites.
	1887.												
147	June 20	June 21	Decided, muddy.	Heavy.	1.00	22.90	9.30	13.60	.1620	.3620 .2042	1.47	–	–
373	July 20	July 21	Decided, milky.	Much, brown.	0.20	42.00	3.25	38.75	.3670	.1340	2.12	–	–
572	Aug. 17	Aug. 18	Slight.	Very heavy, d'rk brown.	2.00	18.50	3.70	14.80	.2000	.1280	1.24	.0100	–
770	Sept. 14	Sept. 16	Decided.	Much, dark brown.	0.05	23.90	7.30	16.60	.2640	.1200	0.93	.0130	–
967	Oct. 17	Oct. 18	Decided.	Much, brown.	1.30	16.60	6.10	10.50	.0884	.0376	0.90	.0160	–
1191	Nov. 15	Nov. 16	Decided, muddy.	Heavy.	–	34.00	10.20	23.80	.5300	.2630 .0730	1.46	.0250	–
1447	Dec. 19	Dec. 20	Decided.	Heavy.	0.90	16.60	6.30	10.30	.2380	.1190 .0600	1.63	.0250	–
	1888.												
1615	Jan. 17	Jan. 18	Decided.	Very heavy.	0.70	25.60	8.40	17.20	.1600	.0680 .0360	0.72	.0450	–
1825	Feb. 14	Feb. 15	Decided, muddy.	Heavy.	0.70	19.20	7.15	12.05	.3180	.1000	1.43	.0400	.0005
2013	Mar. 15	Mar. 16	Decided.	M'ch, e'rthy and floc't.	0.50	10.10 8.20	3.50 3.00	6.60 5.20	.0910	.0690	0.62	.0250	.0008
2204	Apr. 12	Apr. 13	Decided.	Consid'ble, brown.	0.45	7.10	2.20	4.90	.0690	.0810	0.84	.0400	.0012
2401	May 10	May 11	Decided.	Much, brown.	0.70	10.80	3.40	7.40	.1320	.0880 .0360	0.98	.0250	.0016
2581	June 11	June 12	Decided, muddy.	Very heavy, rusty.	0.10	8.30	0.90	7.40	.3350	.1680 .0350	1.02	.0300	.0087
2757	July 11	July 12	Distinct, muddy.	H'vy, e'rthy and floc't.	–	35.10 23.30	9.80 6.90	25.30 16.40	.3250	.0850 .0440	2.23	.0800	.0026
2932	Aug. 14	Aug. 15	Distinct.	Heavy, black.	0.90	55.70	8.85	46.85	.5670	.1190 .0830	1.98	.0070	.0020
3156	Sept. 11	Sept. 12	Decided.	Heavy, brown.	0.70	86.65	5.75	80.90	.1430	.1720 .0980	2.14	.0070	.0080
3334	Oct. 9	Oct. 10	Decided, muddy.	H'vy, e'rthy and floc't.	1.00	13.00 8.80	3.80 2.40	9.20 6.40	.1430	.0730 .0370	0.95	.0450	.0021
3538	Nov. 13	Nov. 14	Decided, muddy.	Heavy.	1.10	10.05 8.25	3.45 2.55	6.60 5.70	.0820	.0500 .0370	0.69	.0600	.0014
3700	Dec. 11	Dec. 12	Decided, muddy.	Heavy.	0.15	38.60 8.70	9.60 2.35	29.00 6.35	.1690	.1750 .0520	0.88	.0400	.0028
	1889.												
3853	Jan. 15	Jan. 16	Decided.	Con., e'rthy.	0.45	14.30 8.15	4.00 2.10	10.30 6.05	.1410	.0870 .0350	0.98	.0500	.0018
4046	Feb. 19	Feb. 21	Decided.	Consid'ble.	0.50	13.10 10.75	4.15 2.60	8.95 8.15	.1640	.0830 .0450	0.74	.0060	.0011
4344	Mar. 19	Mar. 20	Decided.	Heavy.	0.60	10.30 7.95	3.95 2.45	6.35 5.50	.1680	.0910 .0490	0.91	.0200	.0012

Chemical Examination of Water from the Blackstone River below Quinsigamond Village, Worcester — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
4522	Apr. 16	Apr. 17	Decided.	Heavy.	0.90	12.10	4.05	8.05	.1880	.1140	0.91	.0300	.0021
						8.85	2.65	6.20		.0790			
4673	May 15	May 16	Decided.	Heavy.	0.60	22.05	6.50	15.55	.2400	.1360	0.77	.0550	.0060
						10.45	1.90	8.55		.0380			
Av.	....	....	....	....	0.70	23.83	5.66	18.17	.2160	.1218	1.19	.0315	.0027

Hardness in May, 1888, 2.2. Odor, generally offensive.—— The color is often due to iron, and the water has frequently an acid reaction. The samples were collected from the river about 200 feet below the iron bridge, which is the first bridge below the Quinsigamond Iron and Wire Works.

Microscopical Examination.

	1888. June.	1888. July.	1888. Aug.	1888. Sept.	1888. Oct.	1888. Nov.	1888. Dec.	1889. Jan.	1889. Feb.	1889. Mar.	1889. Apr.	1889. May.
1. Blue-green Algæ, ...	0.3	0.0	0.0	0.0	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	5.4	0.4	1.6	4.6	4.3	0.3	0.1	0.1	0.0	0.4	0.2	0.0
3. Fungi, ...	10.0	2.2	2.0	0.0	0.6	0.0	0.6	0.1	0.0	0.4	0.0	0.0
4. Animal Forms, ...	3.2	0.0	0.1	1.8	0.0	pr.	0.0	pr.	0.1	0.2	0.0	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ, *Scenedesmus;* Desmidiaceæ; Diatomaceæ, *Melosira*, *Synedra*, *Tabellaria*. 3. Schizomycetes, *Crenothrix*, *Leptothrix*. 4. Protozoa, *Dinobryon*, *Monas;* Rotifera.

Chemical Examination of Water from the Blackstone River at Uxbridge.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
149	June 20	June 21	Decided.	Sli't, rusty.	0.30	6.65	1.52	5.13	.1140	.0361	0.77	.0190	-
379	July 21	July 22	Slight.	Sli't, brown.	0.40	7.27	1.27	6.00	.1320	.0330	0.82	.0520	-
571	Aug. 18	Aug. 18	Distinct.	Sli't, brown.	0.45	7.05	1.65	5.40	.0264	.0270	0.66	.0650	-
757	Sept. 14	Sept. 14	Distinct.	Sli't, e'rthy.	0.30	7.37	1.40	5.97	.0492	.0216	0.71	.0390	-

Chemical Examination of Water from the Blackstone River at Uxbridge — Con.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
973	Oct. 18	Oct. 19	Slight.	Con., brown.	0.50	7.55	1.35	6.20	.1672	.0256	0.81	.0260	–
1204	Nov. 16	Nov. 17	Sli't, milky.	Very slight.	0.40	7.45	1.20	6.25	.1888	.0192	0.96	.0150	–
1453	Dec. 20	Dec. 21	Decided.	Con., e'rthy.	0.70	8.15	1.65	6.50	.1260	.0380	0.80	.0250	–
	1888.												
1633	Jan. 18	Jan. 20	Decided.	Con., rusty.	0.70	7.50	1.85	5.65	.0798	.0206	0.60	.0450	–
1837	Feb. 15	Feb. 16	Distinct.	Heavy, rusty.	0.45	7.10	1.55	5.55	.1030	.0340	0.62	.0350	.0010
2014	Mar. 15	Mar. 16	Decided.	Slight.	0.30	5.50	1.10	4.40	.0790	.0280	0.50	.0250	.0006
2209	Apr. 13	Apr. 14	Distinct.	Con., e'rthy and floc't.	0.80	5.05	1.00	4.05	.0400	.0250	0.36	.0250	.0005
2404	May 11	May 12	Decided.	Sli't, brown.	0.30	6.20	1.25	4.95	.1160	.0380	0.64	.0200	.0010
2582	June 12	June 12	Distinct.	Sli't, rusty.	0.30	6.25	1.10	5.15	.0960	.0310 .0270	0.63	.0300	.0016
2762	July 12	July 12	Distinct.	Sli't, brown.	0.45	6.70	1.45	5.25	.1570	.0340 .0330	0.71	.0300	.0007
2934	Aug. 15	Aug. 15	Distinct.	Slight.	0.35	6.95	1.60	5.35	.1730	.0180 .0140	1.05	.0230	.0003
3164	Sept. 12	Sept. 13	Slight.	Sli't, rusty.	0.10	8.15	1.70	6.45	.1790	.0330 .0220	0.87	.0330	.0004
3335	Oct. 10	Oct. 10	Decided.	Much, e'rthy and floc't.	0.60	6.80 5.80	2.30 1.70	4.50 4.10	.0520	.0340 .0250	0.45	.0400	.0010
3542	Nov. 14	Nov. 14	Decided.	Con., e'rthy and floc't.	0.50	5.65 4.70	1.55 1.55	4.10 3.15	.0360	.0230 .0120	0.40	.0300	.0005
3699	Dec. 12	Dec. 12	Distinct.	Consid'ble.	0.50	6.30 5.70	1.75 1.40	4.55 4.30	.0640	0220 .0140	0.53	.0500	.0010
	1889.												
3858	Jan. 16	Jan. 17	Slight, milky.	Very slight.	0.40	4.60	1.10	3.50	.0390	.0170 .0140	0.42	.0300	.0007
4062	Feb. 20	Feb. 21	Decided.	Con., e'rthy and floc't.	0.25	6.50 5.10	1.60 1.30	4.90 3.80	.0960	.0440 .0210	0.57	.0100	.0012
4347	Mar. 20	Mar. 20	Distinct.	Very slight.	0.10	5.35 5.05	1.10 1.05	4.25 4.00	.0720	.0120 .0070	0.50	.0050	.0007
4523	Apr. 17	Apr. 17	Distinct.	Con., rusty.	0.35	5.40	0.95	4.45	.1080	.0390 .0280	0.56	.0090	.0010
4679	May 16	May 17	Distinct.	Con., e'rthy and floc't.	0.10	6.10	1.15	4.95	.1320	.0340 .0210	0.66	.0200	.0016
Av.	....	....	....	....	0.40	6.67	1.48	5.19	.1011	.0286	0.65	.0292	.0009

Hardness in May, 1888, 2.2. Odor, generally musty and disagreeable.—The samples were collected from the canal from the upper dam of the Calumet Woolen Company, just before the water passes the screens to the wheels.

Microscopical Examination.

	1888.							1889.				
	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ, ...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	3.9	1.0	1.7	3.5	1.5	0.3	0.1	pr.	0.1	0.1	pr.	3.5
3. Fungi, ...	0.0	0.0	pr.	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, ...	0.7	6.1	0.9	2.0	0.6	pr.	0.1	0.0	0.0	0.5	pr.	2.3

Groups and principal genera of organisms observed: 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Asterionella*, *Synedra*, *Tabellaria*. 3. Schizomycetes. 4. Protozoa, *Dinobryon*; Spongiaria; Rotifera; Entomostraca.

Chemical Examination of Water from the Blackstone River at Millville, Blackstone.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
148	June 20	June 21	Slight.	None.	0.20	5.52	1.82	3.70	.0565	.0232	.53	.0060	–
372	July 20	July 21	Very slight.	Consid'ble.	0.50	4.80	1.00	3.80	.0396	.0230	.42	.0130	–
580	Aug. 19	Aug. 20	None.	Slight.	0.50	5.22	1.07	4.15	.0050	.0243	.41	.0330	–
779	Sept. 15	Sept. 16	Slight.	Very slight.	0.15	5.30	1.35	3.95	.0128	.0212	.52	.0330	–
987	Oct. 19	Oct. 20	Distinct.	Slight.	0.30	5.50	1.35	4.15	.0776	.0232	.59	.0260	–
1189	Nov. 15	Nov. 16	Distinct.	Very slight.	0.20	5.20	1.10	4.10	.0896	.0172	.59	.0150	–
1452	Dec. 20	Dec. 21	Distinct.	Sli't, e'rthy.	0.50	5.60	1.25	4.35	.0636	.0312	.53	.0180	–
	1888.												
1619	Jan. 18	Jan. 19	Decided.	Very slight.	0.70	5.35	1.35	4.00	.0364	.0192	.36	.0200	–
1841	Feb. 16	Feb. 17	Sli't, milky.	Very slight.	0.30	5.20	1.30	3.90	.0550	.0190	.44	.0280	.0005
2009	Mar. 15	Mar. 15	Sli't, milky.	Very slight.	0.40	5.20	1.20	4.00	.0610	.0180	.44	.0250	.0006
2212	Apr. 14	Apr. 14	Distinct.	Sli't, e'rthy.	0.70	3.95	1.15	2.80	.0190	.0200	.30	.0200	.0006
2410	May 14	May 14	Decided.	Con., e'rthy.	0.60	5.00	1.35	3.65	.0480	.0270	.38	.0120	.0004
2586	June 12	June 13	Distinct.	Con., e'rthy.	0.45	4.15	0.80	3.35	.0340	.0330 .0210	.38	.0200	.0007
2765	July 12	July 13	Slight.	Slight	0.20	5.10	1.50	3.60	.0630	.0340 .0340	.53	.0300	.0003
2930	Aug. 14	Aug. 14	Distinct.	Consid'ble.	0.20	6.80	1.85	4.95	.0710	.0280 .0210	.81	.0400	.0003
3169	Sept. 14	Sept. 14	Slight.	Slight.	0.20	5.55	1.05	4.50	.0630	.0250 .0250	.61	.0320	.0001
3366	Oct. 12	Oct. 13	Distinct.	Con., rusty.	0.90	5.15	1.80	3.35	.0220	.0320 .0240	.35	.0200	.0005
3551	Nov. 15	Nov. 16	Distinct.	Sli't, e'rthy.	0.50	4.55	1.40	3.15	.0270	.0260 .0150	.34	.0250	.0006
3709	Dec. 13	Dec. 14	Distinct, milky.	Con., brown.	0.45	5.00 4.60	1.30 1.15	3.70 3.45	.0330	.0230 .0160	.38	.0180	.0007

Chemical Examination of Water from the Blackstone River at Millville, Blackstone — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
3859	Jan. 16	Jan. 17	Sli't, milky.	Slight.	0.20	4.10 3.85	1.00 0.80	3.10 3.05	.0150	.0202 .0138	.32	.0200	.0004
4101	Feb. 21	Feb. 23	Decided.	Heavy.	0.50	5.20	1.40	3.80	.0430	.0230	.41	.0210	.0005
4360	Mar. 21	Mar. 22	Distinct.	Veryslight, flocculent.	0.20	4.85 4.20	1.25 0.90	3.60 3.30	.0620	.0340 .0200	.46	.0090	.0007
4542	Apr. 19	Apr. 20	Distinct.	Con.,e'rthy.	0.30	4.15	1.10	3.05	.0600	.0340 .0230	.40	.0070	.0008
4680	May 16	May 17	Distinct.	Con., floc't.	0.20	4.65	1.20	3.45	.0352	.0286 .0204	.49	.0150	.0004
Av.	....	....	....	....	0.39	5.06	1.26	3.80	.0455	.0253	.46	.0211	.0005

Hardness in May, 1888, 1.5. Odor, generally musty and disagreeable. —— The samples were collected from the river at the bridge just above the dam in the village of Millville.

Microscopical Examination.

	1888. June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	1889. Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ, ...	0.0	0.0	pr.	pr.	pr.	0.1	0.0	0.0	0.0	0.0	0.1	0.0
2. Other Algæ, ...	1.6	5.5	1.8	2.8	0.8	0.7	0.1	0.1	0.3	pr.	0.5	1.3
3. Fungi, ...	0.8	0.3	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, ...	0.3	1.4	0.1	3.4	0.2	2.3	0.0	0.0	0.0	0.1	0.1	0.3

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Synedra, Tabellaria.* 3. Schizomycetes, *Crenothrix.* 4. Protozoa, *Dinobryon;* Rotifera; Entomostraca.

Table showing the Flow of the Blackstone River at Various Points at or near where Samples of Water were collected for Analysis.

MONTH.	Worcester, Mass., at Dam of Quinsigamond Iron and Wire Works.			Millbury, Mass., at Dam of Cordis Manufacturing Company.			Uxbridge, Mass., at Upper Dam of Calumet Woolen Company.			Blackstone, Mass., at Dam of Blackstone Manufacturing Company.		
	Day of Month on which Sample was collected for Analysis.	Flow during Working Hours on the Day the Sample was collected. Cu.ft. per sec.	Average Flow during Working Hours for the Month. Cu.ft per sec.	Day of Month on which Sample was collected for Analysis.	Flow during Working Hours on the Day the Sample was collected. Cu.ft. per sec.	Average Flow during Working Hours for the Month. Cu.ft. per sec.	Day of Month on which Sample was collected for Analysis.	Flow during Working Hours on the Day the Sample was collected. Cu.ft. per sec.	Average Flow during Working Hours for the Month. Cu.ft. per sec.	Day of Month on which Sample was collected for Analysis.	Flow during Working Hours on the Day the Sample was collected. Cu.ft. per sec.	Average Flow during Working Hours for the Month. Cu.ft. per sec.
1887.												
September, .	14	140	114	14	-	111	14	260	208	15	-	330
October, .	17	120	121	17	102	110	18	216	237	19	363	352
November, .	15	96	105	15	137	96	16	330	209	15	372	355
December, .	19	128	127	19	155	127	20	204	257	20	374	390
1888.												
January, .	17	144	217	17	192	221	18	262	468	18	373	608
February, .	14	128	202	14	116	271	15	466	594	16	-	-
March, .	15	161	232	15	271	408	15	522	577	15	-	1,117
April, . .	12	335	222	12	426	326	13	710	570	14	1,048	1,065
May, . .	10	115	146	10	155	215	11	394	451	14	1,450	579
June, . .	11	115	121	11	98	154	12	246	280	12	344	365
July, . .	11	105	-	11	91	92	12	214	182	12	361	330
August, .	14	-	-	14	74	89	15	269	276	14	294	321
September, .	11	-	-	11	78	126	12	188	269	14	354	404
October, .	9	-	-	9	356	235	10	418	370	12	603	645
November, .	13	-	-	13	280	319	14	580	588	15	665	938
December, .	11	-	-	11	223	492	12	-	-	13	876	1,475

Charles River.

The Charles River drains an area of 307.5 square miles in the eastern part of Massachusetts. It rises in Milford and flows in a north-easterly direction to Boston Harbor, a distance of 28 miles measured in a straight line, and as many as 70 miles following the very circuitous course of the stream. The river is affected by the tides as far up as Watertown, ten miles above its mouth. Between Watertown and Newton Upper Falls the river falls 85 feet in 10 miles, and practically all of this fall is utilized for water power. Between Newton Upper Falls and the southerly part of Millis, a distance of about 32 miles, the stream has a total fall of only 28 feet, most of which is concentrated at the dams at Charles River Village and South Natick. The greater part of the way the stream is very sluggish and meanders through extensive meadows which are overflowed at high stages of the river. The valley contains few ponds or lakes and no large storage reservoirs, and the dry weather flow of the river is small.

The land in the valley is generally rolling and in places somewhat hilly. The lower lands, with the exception of the meadows, are generally composed of gravel or sand. Much of the land is devoted to farming and is not well wooded.

Near Dedham the divide between the Charles and Neponset River valleys is very low, and a channel was dug at this place many years ago, to divert a portion of the water from the Charles into the Neponset River through Mother Brook. It has been decided by the courts that Mother Brook is entitled to one-third of the water of the Charles River at the point of diversion.

The following table gives statistics of drainage areas and populations at several points on the river at and above Watertown.

LOCALITY.	Distance from Tide Water at Watertown. Miles.	Drainage Area. Sq. Miles.	Estimated Population (1888).	Population per Square Mile.
Above Milford, opposite wells of Milford Water Co.,*	60.0	3.7	484	129
Below Milford, ...	58.0	12.2	8,230	675
At the dam at South Natick,*	29.5	154.7	25,090	162
Just above Mother Brook, ...	17.0	198.6	33,300	168
Just below Mother Brook (see note), ...	17.0	132.4	22,200	168
At Brookline Water Works Pumping Station,* . .	15.0	–	–	–
At Newton Water Works Pumping Station,* . .	12.0	140.5	24,300	173
At Newton Upper Falls,†	11.0	144.3	–	–
At Waltham Water Works Pumping Station,* . .	4.7	181.0	33,350	184
At Ætna Mills, Watertown,* †	1.0	197.8	57,210	289

NOTE.—In order to allow for the diversion of one-third of the flow of Charles River into Mother Brook, a corresponding reduction has been made in the drainage areas and populations at points further down stream. The drainage area and population at the Brookline Water Works Pumping Station are about midway between those given for Mother Brook and the Newton Water Works Pumping Station.

* Points at which samples of water were collected for analysis.
† Points at which measurements of the flow of the river were made.

The greatest density of population is seen in the above table to be below Milford, which is situated near the head waters of the river. Farther down stream the population per square mile is much smaller and remains nearly uniform as far as Dedham. Below this place the population in the valley increases more and more rapidly to the mouth of the river, the valley adjoining the tidal portion of the river containing a very large population in the cities of Boston and Cambridge.

Many of the cities and towns in this valley have a public water supply. Of these, Milford, Dedham, Brookline, Newton, Wellesley, Waltham and Watertown obtain their supply from wells or filter-galleries on or near the banks of the river; Franklin obtains its supply from wells on the bank of Mine Brook, one of the tributaries of the river; Cambridge takes water from Stony Brook, a tributary which enters the river just above Waltham, and Lincoln obtains a supply from Sandy Pond at the head of Stony Brook. Portions of the town of Natick and of the West Roxbury District of Boston within this valley are supplied with water from outside sources. More or less manufacturing and domestic sewage is turned into the river from the factories and towns in the valley, but no town has

any extensive system of sewerage discharging into the river above Watertown. The town of Medfield purifies its sewage by filtration before discharging it into the stream.

An examination of the Charles River basin was made by the State Board of Health in 1875, and a list was prepared giving the number of mills and factories on the streams in the valley, the number of operatives employed and other information relating to the pollution of the river, which may be found in the report of the Board for 1876, pp. 98–108. A further examination of the valley was made in 1885, by the Massachusetts Drainage Commission,* the results of which are given in detail on pp. 35–63 of its report. The later examination shows an increase in the amount of sewage and manufacturing waste entering the river, though it cannot be called a badly polluted stream above Waltham. Below this city the stream is much more polluted, particularly its tidal portion, and a remedy is being provided by the construction of the Metropolitan System of Sewerage to intercept the sewage and carry it out to sea.

Examinations of the river water were made monthly from June, 1887, to May, 1889, at five places, namely, Watertown at Ætna Mills; opposite the pumping stations of the Waltham, Brookline and Newton water works, and at South Natick. Samples were also taken occasionally from the river at Milford, near the wells of the Milford Water Company. Records of the flow of water in the river at Newton Upper Falls and at Watertown, and of the flow in Mother Brook at East Dedham, were kept from October, 1887, to December, 1888.

In the valley above South Natick, there were in 1885, 12 factories or mills employing 900 operatives, which discharged polluting material of some sort into the stream. The others were not thought to cause a sensible amount of pollution. None of these factories are within about 13 miles, by the river, of the point where the samples were collected at South Natick. Between this point and the Brookline Pumping Station, there were in 1885 only two polluting mills — a paper and a paint mill — employing together about 48 hands. The sewage from Hotel Wellesley, which contains in summer about 600 boarders, and that from Wellesley College, with about the same population, also enters the river or a tributary.

The distance between the Brookline and Newton pumping

* Report of a Commission appointed to consider a General System of Drainage for the Valleys of the Mystic, Blackstone and Charles rivers.

stations is but three miles, and there are no mills or population between these points to appreciably affect the quality of the water. Between the Newton and Waltham pumping stations the manufacturing villages of Newton Upper and Lower Falls are situated, and there were, in 1885, 15 mills, employing about 1,030 operatives, of which four, employing 465 operatives, were not considered polluting. On the river between the Waltham Pumping Station and the Ætna Mills at Watertown there is a large concentrated population in the city of Waltham, and there were, in 1885, six mills, employing 4,170 hands, which discharged polluting material of some sort into the stream.

Tables of analyses of the river water, with a summary of the same, and tables of the volume flowing in the river are appended. Analyses of other surface waters in the valley have already been published in the preceding portion of this report as follows: —

Cambridge, Stony Brook Reservoir in Waltham, . . page 89
Concord, Sandy Pond in Lincoln, ... page 108
Franklin, Beaver Pond, ... page 133
Franklin, Mine Brook, ... page 133
Needham, Rosemary Pond, ... page 237
Newton, Hammond's Pond, ... page 249
Wellesley, Rosemary Brook, ... page 346
Wellesley, Waban Lake, ... page 347

Chemical Examination of Water from the Charles River at Milford.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
1431	Dec. 16	Dec. 17	Very slight.	Very slight.	1.10	4.50	2.10	2.40	.0035	.0269	.30	.0080	-
	1888.												
2126	Mar. 30	Mar. 31	Distinct.	Very slight.	0.45	2.70	1.00	1.70	.0000	.0205	.19	.0080	.0000
2491	May 22	May 23	Slight.	Very slight.	0.70	3.00	1.30	1.70	.0002	.0260	.18	.0030	.0000
Av.	....	....	....	....	0.75	3.40	1.47	1.93	.0012	.0245	.22	.0063	.0000

Hardness in May, 1888, 1.0. Odor, faintly vegetable.——The samples were collected from the river near the pumping station of the Milford Water Company.

Microscopical Examination.

March, May, 1888. 1. Blue-green algæ, 0.0; 2. Other algæ, pr.; 3. Fungi, 0.0; 4. Animal forms, pr. Groups and principal genera of organisms observed: 2. Palmellaceæ; Zoosporeæ; Diatomaceæ. 4. Protozoa.

Chemical Examination of Water from the Charles River at South Natick.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.		Nitrates.	Nitrites.
	1887.												
249	July 5	July 6	Very slight.	None.	0.90	5.10	1.80	3.30	.0010	.0286	.35	.0000	–
500	Aug. 8	Aug. 9	None.	None.	1.40	5.95	1.97	3.98	.0012	.0302	.35	.0070	–
725	Sept. 9	Sept. 10	Distinct.	Slight.	0.75	5.60	1.60	4.00	.0003	.0348	.44	.0030	–
932	Oct. 11	Oct. 12	Very slight.	None.	0.50	4.90	1.10	3.80	.0005	.0225	.47	.0100	–
1110	Nov. 7	Nov. 8	Slight.	Sli't, brown.	0.60	5.30	1.55	3.75	.0000	.0267	.54	.0080	–
1372	Dec. 9	Dec. 10	Slight.	Slight.	0.90	5.85	1.70	4.15	.0020	.0276	.45	.0100	–
	1888.												
1556	Jan. 9	Jan. 10	Very slight.	Very slight.	1.10	4.85	2.30	2.55	.0006	.0262	.31	.0200	.0000
1743	Feb. 3	Feb. 4	Slight.	Very slight.	0.70	5.55	1.95	3.60	.0030	.0239	.38	.0250	.0000
1946	Mar. 4	Mar. 5	Distinct.	Very slight.	0.75	4.30	1.65	2.65	.0004	.0294	.23	.0070	.0000
2163	Apr. 6	Apr. 7	Very slight.	Slight.	0.80	3.55	1.50	2.05	.0002	.0232	.21	.0060	.0004
2365	May 7	May 8	Very slight.	Very slight.	1.30	4.40	1.70	2.70	.0012	.0272	.32	.0050	.0001
2577	June 7	June 8	Very slight.	Slight.	1.30	4.68	1.65	3.03	.0018	.0368 .0316	.25	.0050	.0003
2700	July 3	July 3	Very slight.	Very slight.	0.80	4.30	2.00	2.30	.0002	.0280 .0234	.32	.0080	.0001
2890	Aug. 6	Aug. 8	Very slight.	Very slight.	0.50	4.85	1.60	3.25	.0000	.0206 .0206	.37	.0030	.0000
3211	Sept. 18	Sept. 19	Very slight.	Slight.	0.70	5.05	1.85	3.20	.0024	.0314 .0236	.37	.0050	.0002
3350	Oct. 10	Oct. 11	Very slight.	Very slight.	1.70	5.50	2.90	2.60	.0016	.0294 .0274	.37	.0100	.0001
3529	Nov. 12	Nov. 13	Very slight.	Very slight.	1.30	4.75	2.10	2.65	.0000	.0292 .0252	.36	.0070	.0002
3667	Dec. 6	Dec. 7	None.	Very slight.	0.55	3.60	1.60	2.00	.0006	.0162 .0148	.33	.0080	.0001
	1889.												
3875	Jan. 18	Jan. 19	Very slight.	Very slight.	0.35	3.20	1.05	2.15	.0004	.0172 .0156	.29	.0030	.0005
3967	Feb. 4	Feb. 5	Very slight.	Very slight.	0.40	3.50	0.95	2.55	.0004	.0198 .0168	.29	.0070	.0003
4068	Feb. 20	Feb. 21	Distinct.	Slight.	0.45	3.65	1.15	2.50	.0008	.0204 .0182	.25	.0030	.0003
4215	Mar. 4	Mar. 5	Slight.	Slight.	0.40	3.85	1.60	2.25	.0000	.0200 .0168	.32	.0300	.0002
4494	Apr. 11	Apr. 11	Very slight.	Very slight.	0.75	3.60	1.50	2.10	0012	.0278 .0256	.32	.0050	.0002
4631	May 8	May 9	Slight.	Slight.	1.20	4.80	2.15	2.65	.0034	.0436 .0390	.39	.0050	.0002
4755	May 31	May 31	–	–	1.80	5.30	2.60	2.70	.0040	.0430 .0380	.27	.0030	.0000
Av.	....	....	....	....	0.88	5.03	1.71	3.32	.0011	.0273	.34	.0081	.0002

Hardness in May, 1888, 1.7. Odor, faintly vegetable. —— The samples were collected from the river just above the dam at South Natick.

Microscopical Examination.

	1888.							1889.						
	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Feb.	Mar.	Apr.	May.	May.
1. Blue-green Algæ, .	0.0	0.0	0.0	0.0	0.0	pr.	0.0	0.0	0.0	0.0	0.0	pr.	0.0	0.0
2. Other Algæ, . .	pr.	0.2	0.1	0.3	0.0	0.6	pr.	0.4	0.1	2.8	0.2	1.3	3.1	1.0
3. Fungi, ...	pr.	0.1	0.0	0.0	0.0	0.0	pr.	0.0	0.0	0.0	pr.	0.0	0.0	pr.
4. Animal Forms, . .	0.0	0.1	pr.	0.6	0.0	0.4	0.0	pr.	0.0	0.1	0.2	1.0	pr.	0.3

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Synedra*, *Tabellaria;* Zygnemaceæ; Volvocineæ. 3. Schizomycetes. 4. Protozoa, *Dinobryon;* Entomostraca.

Chemical Examination of Water from Charles River opposite the Filter-Gallery of the Brookline Water Works at West Roxbury.

[Parts per 100,000.]

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.
	1887.												
43	June 6	June 8	Very slight.	None.	1.20	5.15	2.27	2.83	.0042	.0423	.44	–	–
253	July 6	July 6	Very slight.	None.	0.90	4.92	1.77	3.15	.0011	.0251	.38	–	–
494	Aug. 8	Aug. 8	Very slight.	None.	1.10	5.85	1.90	3.95	.0002	.0274	.32	.0070	–
711	Sept. 8	Sept. 9	Slight.	Slight.	0.80	5.67	1.49	4.18	.0010	.0322	.39	.0070	–
913	Oct. 10	Oct. 11	Very slight.	Very slight.	0.40	4.80	1.15	3.65	.0005	.0202	.53	.0130	–
1119	Nov. 8	Nov. 9	Slight.	Slight.	0.60	5.85	1.15	4.70	.0008	.0218	.59	.0080	–
1353	Dec. 8	Dec. 9	Distinct.	Slight.	0.70	6.20	1.95	4.25	.0009	.0278	.52	.0180	–
	1888.												
1557	Jan. 9	Jan. 10	Slight.	Very slight.	1.10	4.95	1.90	3.05	.0010	.0261	.32	.0250	.0000
1765	Feb. 7	Feb. 8	Slight.	Con., e'rthy.	0.60	5.35	1.70	3.65	.0069	.0257	.34	.0200	.0000
1966	Mar. 7	Mar. 8	Slight.	Very slight.	0.70	4.50	1.60	2.90	.0003	.0278	.30	.0100	.0000
2178	Apr. 10	Apr. 11	Distinct.	Very slight.	1.10	3.50	1.45	2.05	.0004	.0247	.24	.0040	.0001
2371	May 8	May 9	Distinct.	Con., dark brown.	0.80	4.10	1.60	2.50	.0022	.0264	.34	.0080	.0000
2557	June 6	June 7	Very slight.	Slight.	1.30	4.80	1.88	2.92	.0034	.0320	.30	.0050	.0003
2705	July 4	July 5	Very slight.	Very slight.	0.60	4.55	1.70	2.85	.0010	.0234 .0216	.35	.0080	.0001
2891	Aug. 7	Aug. 8	Slight.	Very slight.	0.45	4.60	1.40	3.20	.0000	.0228 .0208	.42	.0030	.0001
3343	Oct. 10	Oct. 11	Slight.	Very slight.	1.20	5.30	2.25	3.05	.0026	.0322 .0300	.37	.0080	.0002

Chemical Examination of Water from Charles River opposite the Filter-Gallery of the Brookline Water Works at West Roxbury — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
3447	Oct. 25	Oct. 26	Very slight.	Very slight.	1.30	5.00	2.15	2.85	.0008	.0268 .0258	.42	.0100	.0002
3503	Nov. 7	Nov. 8	Very slight.	Slight.	1.30	5.25	2.40	2.85	.0010	.0298 .0256	.40	.0060	.0001
3655	Dec. 5	Dec. 6	Very slight.	Very slight.	0.50	3.80	1.40	2.40	.0006	.0216 .0186	.36	.0100	.0001
	1889.												
3898	Jan. 22	Jan. 23	Very slight.	Very slight.	0.50	3.40	1.25	2.15	.0000	.0156 .0136	.34	.0060	.0000
3976	Feb. 6	Feb. 7	Very slight.	Very slight.	0.50	3.55	0.80	2.75	.0002	.0152 .0130	.33	.0080	.0002
4054	Feb. 20	Feb. 21	Distinct.	Slight.	0.40	4.00	1.20	2.80	.0002	.0176 .0152	.31	.0060	.0003
4237	Mar. 7	Mar. 8	Distinct.	Slight.	0.30	3.80	1.50	2.30	.0002	.0164 .0150	.35	.0120	.0002
4498	Apr. 11	Apr. 12	Slight.	Very slight.	0.70	3.85	1.30	2.55	.0002	.0224 .0200	.34	.0040	.0004
4632	May 8	May 9	Slight.	Slight.	1.20	4.50	1.95	2.55	.0018	.0306 .0258	.32	.0100	.0002
Av.	....	....	....	....	0.81	5.07	1.66	3.41	.0013	.0254	.37	.0094	.0001

Hardness in May, 1888, 1.6. Odor, generally faintly vegetable, seldom mouldy.——The samples were collected from the river opposite the filter-gallery of the Brookline Water Works at West Roxbury.

Microscopical Examination.

	1888. June.	1888. July.	1888. Aug.	1888. Oct.	1888. Oct.	1888. Nov.	1888. Dec.	1889. Jan.	1889. Feb.	1889. Feb.	1889. Mar.	1889. Apr.	1889. May.
1. Blue-green Algæ, . . .	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	pr.	0.9	1.8	0.2	0.6	pr.	0.0	0.5	0.3	pr.	2.9	0.8	0.9
3. Fungi, ...	1.5	0.5	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, ...	pr.	0.2	0.4	0.5	0.6	0.0	0.0	pr.	pr.	0.0	0.6	pr.	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Synedra*. 3. Schizomycetes, *Crenothrix*. 4. Protozoa; Spongiaria; Annelida; Entomostraca.

Chemical Examination of Water from Charles River opposite the Filter-Basin of the Newton Water Works.

[Parts per 100,000]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
40	June 6	June 7	Very slight.	Slight.	1.00	5.95	1.92	4.03	.0020	.0396	.39	.0000	–
272	July 6	July 7	Slight.	Sli't, brown.	0.70	5.07	1.62	3.45	.0004	.0202	.38	.0000	–
505	Aug. 8	Aug. 9	None.	Slight.	1.00	5.60	1.80	3.80	.0008	.0249	.38	.0000	–
726	Sept. 9	Sept. 10	Slight.	Very slight.	0.70	5.62	1.40	4.22	.0011	.0307	.43	.0070	–
929	Oct. 10	Oct. 12	Very slight.	None.	0.40	5.30	1.25	4.05	.0000	.0208	.50	.0050	–
1123	Nov. 8	Nov. 9	Slight.	Slight.	0.60	5.65	0.95	4.70	.0004	.0242	.62	.0080	–
1364	Dec. 8	Dec. 9	Slight.	Very slight.	0.70	6.20	1.80	4.40	.0004	.0240	.56	.0180	–
	1888.												
1567	Jan. 9	Jan. 11	Slight.	Very slight.	0.70	5.10	2.00	3.10	.0000	.0235	.31	.0250	.0000
1778	Feb. 7	Feb. 9	Very slight.	Very slight, white.	0.50	4.95	1.70	3.25	.0051	.0260	.37	.0230	.0001
1970	Mar. 7	Mar. 8	Distinct.	Slight.	0.70	4.75	1.80	2.95	.0003	.0277	.31	.0100	.0000
2186	Apr. 10	Apr. 11	Distinct.	Slight.	0.65	3.85	1.50	2.35	.0004	.0297	.29	.0050	.0001
2377	May 8	May 9	Distinct.	Con., brown.	0.90	4.55	1.75	2.80	.0028	.0322	.36	.0100	.0001
2562	June 7	June 8	Very slight.	Consid'ble.	1.20	4.65	1.85	2.80	.0012	.0348 .0292	.29	.0060	.0007
2718	July 5	July 6	Very slight.	Very slight.	0.60	4.35	1.65	2.70	.0032	.0240 .0240	.34	.0070	.0000
2893	Aug. 9	Aug. 10	Slight.	Very slight.	0.20	4.35	1.15	3.20	.0000	.0212 .0212	.44	.0020	.0000
3161	Sept. 12	Sept. 13	Very slight.	Very slight.	1.00	6.30	2.65	3.65	.0016	.0340 .0328	.38	.0150	.0001
3355	Oct. 11	Oct. 12	Very slight.	Very slight.	1.90	5.55	2.40	3.15	.0004	.0300 .0262	.37	.0070	.0002
3512	Nov. 8	Nov. 9	Very slight.	Very slight.	1.30	4.90	2.30	2.60	.0010	.0304 .0278	.39	.0080	.0001
3668	Dec. 6	Dec. 7	Very slight.	Very slight.	0.60	3.85	1.55	2.30	.0006	.0180 .0148	.34	.0130	.0001
	1889.												
3932	Jan. 25	Jan. 26	Very slight.	Very slight.	0.50	3.45	1.15	2.30	.0002	.0160 .0144	.31	.0060	.0002
3987	Feb. 7	Feb. 8	Very slight.	Sli't, white.	0.50	3.75	1.20	2.55	.0002	.0140 .0122	.34	.0090	.0002
4080	Feb. 21	Feb. 23	Slight.	Slight.	0.30	3.70	1.05	2.65	.0000	.0178 .0174	.32	.0200	.0004
4241	Mar. 7	Mar. 8	Distinct.	Slight.	0.30	3.60	1.20	2.40	.0000	.0182 .0140	.31	.0090	.0002
4495	Apr. 11	Apr. 12	Slight.	Very slight.	0.70	3.75	1.30	2.45	.0004	.0222 .0212	.33	.0030	.0003
4638	May 9	May 11	Slight.	Consid'ble.	1.20	4.45	2.25	2.20	.0036	.0352 .0318	.32	.0040	.0002
Av.	....	....	....	....	0.75	5.22	1.62	3.60	.0010	.0256	.38	.0088	.0002

Hardness in May, 1888, 1.7. Odor, distinctly vegetable.——The samples were collected from the river.

Microscopical Examination.

	1888.							1889.					
	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ, . .	0.0	0.0	pr.	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	4.4	0.9	0.3	1.2	0.6	0.5	0.9	0.1	4.9	1.8	20.6	2.2	6.7
3. Fungi, ...	0.4	0.0	0.0	pr.	0.5	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, . . .	0.1	pr.	0.1	0.1	0.2	0.5	pr.	0.0	1.2	0.0	0.2	0.2	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Synedra*, *Tabellaria;* Zygnemaceæ. 3. Schizomycetes. 4. Protozoa, *Dinobryon;* Spongiaria; Annelida; Entomostraca.

Chemical Examination of Water from Charles River, near the Filter-Basin of the Waltham Water Works.

[Parts per 100,000.]

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.	Chlorine.	Nitrates.	Nitrites.
	1887.												
62	June 9	June 10	–	–	1.20	6.07	2.32	3.75	.0044	.0440	.40	.0000	–
260	July 6	July 7	Very slight.	None.	0.60	5.50	1.80	3.70	.0034	.0249	.40	.0000	–
501	Aug. 8	Aug. 9	Slight.	Con., brown.	0.70	6.20	1.37	4.83	.0052	.0270	.38	.0030	–
716	Sept. 8	Sept. 9	Slight.	Con., brown.	0.55	6.27	1.40	4.87	.0027	.0271	.50	.0070	–
917	Oct. 10	Oct. 11	Slight.	Very slight.	0.50	5.90	1.10	4.80	.0010	.0241	.57	.0070	–
1128	Nov. 8	Nov. 9	Decided.	Slight.	0.50	6.20	1.75	4.45	.0010	.0192	.66	.0090	–
1350	Dec. 8	Dec. 8	Distinct.	Very slight.	0.50	6.85	2.10	4.75	.0026	.0272	.66	.0200	–
	1888.												
1563	Jan. 9	Jan. 10	Slight.	Very slight.	0.90	5.10	1.95	3.15	.0006	.0271	.35	.0200	.0000
1769	Feb. 7	Feb. 8	Slight.	Very slight, white.	0.60	6.20	1.90	4.30	.0063	.0289	.40	.0270	.0001
1973	Mar. 7	Mar. 8	Slight.	Sli't, earthy.	0.60	4.60	1.70	2.90	.0013	.0251	.32	.0120	.0000
2195	Apr. 11	Apr. 12	Distinct.	Sli't, white.	0.90	4.05	1.40	2.65	.0000	.0250	.28	.0070	.0001
2380	May 8	May 9	Distinct.	Very slight.	0.90	4.50	1.55	2.95	.0026	.0284	.39	.0080	.0001
2593	June 12	June 13	Slight.	Slight.	1.00	5.60	2.00	3.60	.0032	.0366 .0332	.30	.0120	.0002
2728	July 5	July 6	Slight.	Slight.	0.40	5.30	1.75	3.55	.0040	.0324 .0240	.40	.0070	.0001
2904	Aug. 10	Aug. 10	Slight.	Sli't, brown.	0.30	5.30	1.00	4.30	.0040	.0248 .0196	.46	.0030	.0001
3214	Sept. 18	Sept. 19	Very slight.	Very slight.	0.55	5.70	1.60	4.10	.0034	.0316 .0240	.44	.0030	.0003

Chemical Examination of Water from Charles River, near the Filter-Basin of the Waltham Water Works — Concluded.

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.		Nitrates.	Nitrites.
	1888.												
3363	Oct. 12	Oct. 13	Distinct.	Very slight.	1.40	5.50	2.45	3.05	.0026	.0328 .0320	.38	.0120	.0003
3517	Nov. 9	Nov. 10	Very slight.	Slight.	1.30	5.40	2.50	2.90	.0038	.0276 .0262	.47	.0150	.0004
3671	Dec. 7	Dec. 8	None.	Very slight.	0.50	3.90	1.40	2.50	.0002	.0178 .0156	.37	.0100	.0005
	1889.												
3938	Jan. 26	Jan. 28	Very slight.	Very slight.	0.35	3.85	1.05	2.80	.0008	.0164 .0142	.34	.0150	.0002
4001	Feb. 12	Feb. 13	Very slight.	Sli't, earthy and floc't.	0.45	4.25	1.20	3.05	.0004	.0174 .0146	.40	.0200	.0002
4094	Feb. 22	Feb. 23	Slight.	Slight.	0.50	4.40	1.10	3.30	.0000	.0182	.36	.0200	.0005
4257	Mar. 8	Mar. 9	Very slight.	Very slight.	0.30	4.00	1.05	2.95	.0004	.0202 .0172	.37	.0100	.0004
4507	Apr. 12	Apr. 13	Very slight.	Slight.	0.60	4.15	1.55	2.60	.0000	.0250 .0222	.36	.0060	.0002
4644	May 10	May 11	Slight.	Con., earthy and floc't.	1.10	4.85	2.25	2.60	.0060	.0346 .0290	.38	.0070	.0003
Av.	....	....	....	....	0.69	5.62	1.70	3.92	.0024	.0265	.41	.0104	.0002

Hardness in May, 1888, 1.9. Odor, faintly vegetable, occasionally mouldy.—The samples were collected from the river near the filter-basin of the Waltham Water Works.

Microscopical Examination.

	1888.							1889.					
	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ, . .	0.0	0.0	0.0	pr.	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	0.5	4.3	1.1	0.4	0.2	1.8	0.2	0.2	1.7	1.2	1.5	1.6	0.7
3. Fungi, ...	2.5	0.3	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	pr.	0.0	0.0
4. Animal Forms, . . .	3.2	11.5	0.3	0.3	pr.	0.0	pr.	pr.	1.0	pr.	0.3	0.3	60.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Melosira*, *Synedra;* Zygnemaceæ. 3. Schizomycetes, *Leptothrix*. 4. Protozoa, *Dinobryon*; Rotifera.

Chemical Examination of Water from Charles River at Ætna Mills, Watertown.

[Parts per 100,000.]

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.
	1887.												
269	July 7	July 7	Slight.	Con.,brown.	0.90	6.75	2.00	4.75	.0006	.0307	.60	.0030	–
493	Aug. 8	Aug. 8	Slight.	Sli't,brown.	0.60	6.97	1.30	5.67	.0055	.0237	.59	.0350	–
710	Sept. 8	Sept. 8	Distinct.	Slight.	0.60	6.90	1.15	5.75	.0009	.0291	.62	.0130	–
912	Oct. 10	Oct. 10	Slight.	Sli't,earthy and floc't.	0.45	7.15	1.40	5.75	.0056	.0249	.75	.0260	–
1118	Nov. 8	Nov. 9	Distinct.	Sli't, white.	0.30	7.80	2.00	5.80	.0305	.0255	.88	.0400	–
	1888.												
1564	Jan. 9	Jan. 10	Distinct.	Slight.	0.90	5.70	2.00	3.70	.0038	.0298	.38	.0300	.0000
1764	Feb. 7	Feb. 8	Slight.	Con., earthy and floc't.	0.50	7.10	2.00	5.10	.0031	.0286	.48	.0300	.0000
1981	Mar. 9	Mar. 10	Slight.	Con.,earthy and floc't.	0.70	5.75	2.15	3.60	.0046	.0320	.46	.0230	.0003
2182	Apr. 10	Apr. 11	Distinct.	Sli't,brown.	1.00	4.05	1.50	2.55	.0000	.0302	.34	.0100	.0004
2375	May 8	May 9	Distinct.	Con., dark brown.	0.80	6.25	2.20	4.05	.0040	.0322 .0256	.53	.0400	.0004
2712	July 5	July 6	Slight.	Slight.	0.40	6.25	2.10	4.15	.0092	.0248 .0214	.60	.0550	.0017
2901	Aug. 9	Aug. 10	Distinct.	Slight.	0.40	7.95	1.95	6.00	.0046	.0402 .0312	.83	.0150	.0017
3166	Sept. 13	Sept. 14	Slight.	Con.,brown.	0.70	6.95	2.35	4.60	.0032	.0420 .0274	.62	.0400	.0006
3360	Oct. 12	Oct. 13	Slight.	Consid'ble.	1.70	6.40	2.50	3.90	.0036	.0380 .0346	.43	.0250	.0003
3516	Nov. 9	Nov. 10	Slight.	Sli't,ear'hy and floc't.	1.10	6.20	2.35	3.85	.0048	.0326 .0280	.56	.0250	.0007
3662	Dec. 6	Dec. 7	Slight.	Slight.	0.50	4.20	1.35	2.85	.0000	.0204 .0164	.42	.0300	.0004
	1889.												
3935	Jan. 25	Jan. 26	Slight.	Very slight.	0.45	4.05	1.15	2.90	.0000	.0184 .0150	.39	.0120	.0003
3996	Feb. 8	Feb. 9	Distinct.	Slight.	0.45	4.55	1.10	3.45	.0002	.0184 .0146	.43	.0150	.0004
4105	Feb. 23	Feb. 25	Distinct.	Slight.	0.50	4.45	1.20	3.25	.0004	.0216 .0168	.40	.0200	.0004
4250	Mar. 8	Mar. 9	Slight.	Consid'ble.	0.30	4.80	1.45	3.35	.0000	.0208 .0172	.41	.0180	.0008
4505	Apr. 12	Apr. 13	Distinct.	Consid'ble.	0.60	4.75	1.70	3.05	.0000	.0306 .0252	.43	.0150	.0003
4637	May 10	May 11	Distinct.	Con.,brown.	1.00	6.10	2.60	3.50	.0076	.0430 .0354	.49	.0350	.0004
Av.	....	....	....	....	0.68	6.44	1.77	4.67	.0042	.0290	.53	.0252	.0005

Hardness in May, 1888, 2.3. Odor, faintly vegetable, frequently mouldy.—— The samples were collected from the canal at the Ætna Mills, Watertown.

Microscopical Examination.

	1888.						1889.					
	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ,	0.2	0.0	0.0	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ,	2.1	1.1	0.8	0.7	0.4	0.2	pr.	0.1	0.2	1.9	5.5	0.5
3. Fungi,	2.5	5.0	5.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0
4. Animal Forms,	1.1	pr.	0.7	0.1	0.1	pr.	0.0	0.0	0.1	0.6	0.3	0.8

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ, *Chlorococcus;* Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Synedra, Tabellaria;* Zygnemaceæ. 3. Schizomycetes, *Crenothrix.* 4. Protozoa; Spongiaria.

Summary of Analyses of Water from Charles River.

	Color.	Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
		Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
Above Milford,	0.75	3.40	1.47	1.93	.0012	.0245	.22	.0063	.0000
At South Natick,	0.88	5.03	1.71	3.32	.0011	.0273	.34	.0081	.0002
At Brookline Pumping Station,	0.81	5.07	1.66	3.41	.0013	.0254	.37	.0094	.0001
At Newton Pumping Station,	0.75	5.22	1.62	3.60	.0010	.0256	.38	.0088	.0002
At Waltham Pumping Station,	0.69	5.62	1.70	3.92	.0024	.0265	.41	.0104	.0002
At Ætna Mills, Watertown,	0.68	6.44	1.77	4.67	.0042	.0290	.53	.0252	.0005

Table showing the Flow of Charles River and Mother Brook, October, 1887, to December, 1888.

MONTH.	Flow of Charles River at Phipps and Train Mill, Newton Upper Falls, and of Mother Brook at Merchant's Woolen Mill, East Dedham, at times when Samples of Water for Analysis were collected at Newton.					Flow of Charles River at Dam of Ætna Woolen Mill, Watertown.		
		Mother Brook.		Charles River.				
	Day of Month on which Sample was collected for Analysis.	Flow during Working Hours on the Day the Sample was collected. Cu. ft. per sec.	Average Flow during Working Hours for the Month. Cu. ft. per sec.	Flow during Working Hours on the Day the Sample was collected. Cu. ft. per sec.	Average Flow during Working Hours for the Month. Cu. ft. per sec.	Day of Month on which Sample was collected for Analysis.	Flow During Working Hours on the Day the Sample was collected. Cu. ft. per sec.	Average Flow during Working Hours for the Month. Cu. ft. per sec.
1887.								
October,	10	7	18	36	83	10	122	138
November,	8	16	27	86	104	8	122	245
December,	8	26	45	128	157	-	-	296
1888.								
January,	9	122	82	354	227	9	646	500
February,	7	84	129	218	290	7	443	654
March,	7	105	213	234	519	9	714	951
April,	10	224	190	622	504	10	958	900
May,	8	76	118	234	331	8	526	739
June,	7	76	55	142	123	-	-	373
July,	5	34	24	44	25	5	158	121
August,	9	16	25	31	72	9	122	204
September,	12	29	51	94	161	13	387	386
October,	11	121	120	356	330	12	786	739
November,	8	76	152	203	394	9	492	709
December,	6	310	288	775	713	6	948	971

Chicopee River.

The Chicopee River is in the central part of the State, and flows into the Connecticut River from the east at Chicopee. Its basin, which lies wholly within the State, contains an area of 724.6 square miles. The river proper is formed by the confluence of the Swift, Ware and Quaboag rivers, near the village of Three Rivers in the town of Palmer, and flows thence about 17 miles in a westerly direction to its mouth. The river falls, in this distance, about 260 feet, of which 166 feet are utilized for power.

The Swift, Ware and Quaboag rivers are nearly equal in size, and, having a rapid fall, are used extensively for water power. The Quaboag River basin, with an area of 211.9 square miles, contains a number of large ponds with an aggregate area of about 2,070 acres, and some very extensive low meadows, bordering the upper portion of the river, which are flooded when the river is high; consequently the summer flow of the stream is comparatively large. The Ware River has a drainage area of 219.6 square miles, which is much more hilly than the Quaboag, and its capacity for storing water is somewhat less, so that the stream is subject to somewhat greater fluctuations. The Swift River has a drainage area of 217.8 square miles, which is more hilly than either of the others, and, in some places, mountainous. There are fewer lakes and ponds on this stream than on either of the others.

Of the places wholly or in part within the Chicopee basin, Chicopee, Ludlow, Palmer, Warren, West Brookfield, Brookfield, Spencer and Ware, and the village of Indian Orchard in the city of Springfield, have public water supplies. Ware has a system of sewers, built in 1889, discharging into the Ware River below the town. Sewage is also discharged into the main river or its tributaries from portions of the towns of Spencer, Palmer and Ludlow, from the village of Indian Orchard, and from the town of Chicopee. It is also the general custom to discharge the manufacturing wastes and the sewage from water closets used by operatives directly into the stream. The river near its mouth is, however, still in use as a source of water supply for a part of the town of Chicopee.

The Chicopee River basin was examined in 1875 by the engineers of the State Board of Health, and the number of mills and factories in the basin was determined, together with the number of operatives employed. The following table, taken from page 118 of the report

of the Board for 1876, gives a summary of the results obtained by this examination, which will show the general character of the manufacturing in this valley : —

MANUFACTURES.	Number.	Operatives Employed.
Cotton mills,	18	6,228
Foundries and machine shops,	33	1,102
Woolen mills and dye works,	26	1,028
Bleaching works,	1	20
Paper mills,	3	262
Hat works,	1	325
Tanneries,	3	19
Gas works,	6	–
Saw and grist mills,	34	–
Totals,	125	8,984

Samples of water from the river at Chicopee Falls have been examined monthly from June, 1887, to May, 1889. Measurements of the stream were made at the upper dam at Ludlow from October, 1887, to September, 1888. The results are given in appended tables. The following table gives statistics of drainage areas and population of the main river and its branches : —

LOCALITY	Distance from Mouth of Chicopee River. Miles.	Drainage Area. Sq. Miles.	Population (1885).	Population per Square Mile.
Seven-Mile River, just below Spencer,	45.5	30.9	7,933	257
Quaboag River, at mouth,	17	211.9	28,311	134
Ware River, at mouth,	18	219.6	15,300	70
Swift River, at mouth,	18	217.8	7,555	35
Chicopee River, at upper dam, Ludlow,	8.4	688.1	–	–
Chicopee River, at dam, Chicopee Falls,	2.7	716.7	58,581	82

Of the total population above Chicopee Falls, 28,022, or 47.8 per cent., are in five towns having a population of more than 4,000 each. The remainder of the population is located in smaller towns, but much of it is in manufacturing villages near the streams. The

population of the larger towns has increased steadily since 1865, while the smaller towns have generally shown a marked decrease in recent years. This decrease, however, has not been sufficient to offset the gain in the larger towns, and the population of the valley, as a whole, is increasing.

In addition to the tables of analyses given below, examinations of other surface waters in the Chicopee basin have been made, and are given in the preceding portions of this report, as follows: —

Brookfield W. W., storage reservoir, ... page 79
Chicopee W. W., Dingle Brook Storage Reservoir, . . page 96
Chicopee W. W., pond, ... page 98
Ludlow, Wood's Pond, ... page 200
Ludlow, Chapin's Pond, ... page 201
Monson, reservoir, ... page 230
Palmer W. W., reservoir, ... page 264
Phillipston, Phillipston Pond, ... page 267
Spencer W. W., Shaw Pond, ... page 296
Springfield W. W., Ludlow Reservoir, ... page 298
Springfield W. W., Broad Brook, ... page 302
Springfield W. W., Higher Brook, ... page 302
Ware, Muddy Brook, ... page 332

Chemical Examination of Water from the Chicopee River at Ludlow.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1889.												
4268	Mar. 9	Mar. 11	Distinct.	Con., earthy and floc't.	0.25	2.85	0.90	1.95	.0002	.0164 .0134	.13	.0060	.0001

Hardness, 1.2. Odor, very faintly vegetable.——The sample was collected from the river at the upper dam of the Ludlow Manufacturing Company, Ludlow.

Microscopical Examination.

March, 1889. 1. Blue-green algæ, 0.0; 2. Other algæ, 0.1; 3. Fungi, 0.0; 4. Animal forms, 0.4.
Groups and principal genera of organisms observed: 2. Diatomaceæ. 4. Protozoa.

Chemical Examination of Water from the Chicopee River at Chicopee Falls.

[Parts per 100,000.]

Number.	Date of: Collection.	Date of: Exam-ination.	Appearance: Turbidity.	Appearance: Sediment.	Appearance: Color.	Residue on Evaporation: Total.	Residue on Evaporation: Loss on Ignition.	Residue on Evaporation: Fixed.	Ammonia: Free.	Ammonia: Albu-minoid.	Chlorine.	Nitrogen as: Nitrates.	Nitrogen as: Nitrites.
	1887.												
137	June 17	June 18	Slight.	Consid'ble, rusty.	0.45	4.82	1.45	3.37	.0012	.0162	.17	.0130	–
366	July 19	July 20	Slight.	Consid'ble, rusty.	0.60	4.64	1.32	3.32	.0027	.0185	.19	.0070	–
563	Aug. 16	Aug. 18	Slight.	Slight.	1.00	5.05	1.52	3.53	.0026	.0238	.14	.0100	–
787	Sept. 15	Sept. 16	Decided.	Consid'ble.	0.45	4.35	0.95	3.40	.0026	.0188	.15	.0030	–
975	Oct. 17	Oct. 19	Slight.	Slight.	0.60	4.95	1.15	3.80	.0011	.0196	.24	.0080	–
1196	Nov. 15	Nov. 16	Distinct.	Slight.	0.40	4.20	1.10	3.10	.0006	.0155	.23	.0100	–
1442	Dec. 19	Dec. 20	Distinct.	Slight.	0.40	4.05	1.15	2.90	.0012	.0141	.21	.0120	–
	1888.												
1609	Jan. 16	Jan. 17	Distinct	Slight, earthy.	0.30	3.95	1.10	2.85	.0000	.0109	.13	.0200	.0000
1843	Feb. 15	Feb. 17	Very slight.	Very slight.	0.40	3.90	0.85	3.05	.0040	.0159	.15	.0200	.0000
2019	Mar. 14	Mar. 16	Distinct.	Slight.	0.20	3.75	0.90	2.85	.0010	.0118	.17	.0100	.0002
2214	Apr. 13	Apr. 14	Very slight.	Slight, earthy.	0.30	3.00	0.95	2.05	.0004	.0142	.13	.0080	.0003
2407	May 11	May 12	Slight.	Slight.	0.25	3.40	1.20	2.20	.0012	.0126	.14	.0080	.0002
2643	June 20	June 21	Distinct.	Slight, green.	0.60	3.55	1.20	2.35	.0024	.0160	.12	.0060	.0002
2773	July 12	July 13	Slight.	Very slight.	0.30	4.55	1.55	3.00	.0038	.0178 .0140	.15	.0080	.0002
2950	Aug. 16	Aug. 17	Slight.	Slight, white.	0.25	4.65	0.95	3.70	.0018	.0162 .0126	.22	.0070	.0001
3224	Sept. 19	Sept. 20	Slight.	Considera-ble.	0.50	4.35	1.50	2.85	.0020	.0236 .0206	.19	.0120	.0001
3386	Oct. 17	Oct. 18	Slight.	Very slight.	1.00	4.00	1.35	2.65	.0002	.0150 .0144	.17	.0080	.0001
3586	Nov. 21	Nov. 22	Slight.	Slight.	0.50	3.45	1.10	2.35	.0000	.0140 .0128	.16	.0100	.0004
3765	Dec. 19	Dec. 20	Decided.	Heavy, earthy and flocculent.	0.40	2.60	1.05	1.55	.0002	.0202 .0116	.07	.0100	.0003
	1889.												
3911	Jan. 22	Jan. 24	Slight, milky.	Very slight.	0.20	2.95	0.65	2.30	.0000	.0132 .0102	.14	.0120	.0002
4155	Feb. 27	Feb. 28	Slight.	None.	0.20	3.70	0.85	2.85	.0000	.0126 .0070	.19	.0100	.0000
4415	Mar. 27	Mar. 28	Very slight.	Very slight.	0.30	3.25	0.85	2.40	.0000	.0124 .0100	.12	.0080	.0001
4563	Apr. 24	Apr. 25	Very slight.	Considera-ble, light.	0.25	3.30	0.90	2.40	.0012	.0164 .0142	.14	.0100	.0004
4718	May 22	May 23	Slight.	Considera-ble.	0.50	3.95	1.05	2.90	.0048	.0224 .0176	.14	.0060	.0003
Av.	....	....	....	....	0.43	4.17	1.14	3.03	.0015	.0163	.16	.0098	.0002

Odor, generally faintly vegetable, seldom mouldy.——The samples were collected from a faucet in the pumping station, with the exception of No. 137, which was collected from the canal just over the inlet to the water works.

Microscopical Examination.

	1888.							1889.				
	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ,	pr.	0.0	pr.	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.7
2. Other Algæ,	1.6	0.9	1.5	0.5	0.1	0.3	3.9	0.1	0.1	0.1	4.3	8.8
3. Fungi,	0.1	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal forms,	0.1	pr.	0.0	0.0	0.0	pr.	pr.	0.0	0.0	pr.	0.3	0.1

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Synedra, Tabellaria.* 3. Schizomycetes. 4. Protozoa; Spongiaria.

Table showing the Flow of the Chicopee River at the Upper Dam of the Ludlow Manufacturing Company.

MONTH.	Day of Month on which Sample was collected for Analysis at Chicopee Falls.	Flow during Working Hours on the Day the Sample was collected. Cu. ft. per sec.	Average Flow during Working Hours for the Month. Cu. ft. per sec.
1887.			
October,	17	593	616
November,	15	586	725
December,	19	1,072	971
1888.			
January,	16	974	1,236
February,	15	678	1,806
March,	14	556	2,137
April,	13	3,474	3,204
May,	11	1,302	1,617
June,	20	616	778
July,	12	536	529
August,	16	415	553
September,	19	1,853	1,370

Concord River.

The Concord River is formed by the confluence of the Sudbury and Assabet rivers at Concord, and, after flowing in a northerly direction about 16 miles, empties into the Merrimack River in the eastern part of the city of Lowell. Its drainage area of 402.1 square miles is wholly within the State.

Between North Billerica and its mouth, a distance of about 4.5 miles, the river falls quite rapidly, and its power is fully utilized by mills. Above North Billerica the main river and the Sudbury

are extremely sluggish nearly to Saxonville, the fall in 22 miles or more being less than two inches per mile. Throughout nearly all of this level portion the river is bordered by extensive meadows, subject to inundation, some of them being permanently wet. The upper portion of the Sudbury River is used as a source of water supply for the city of Boston, and has been fully described on pp. 29–34 of this report. The Assabet River has considerable fall, and is used in many places for water power; its drainage area is hilly, and contains much less swamp and meadow than is found near the Concord and the lower part of the Sudbury.

The area and population above different points on the Concord River and its tributaries are given in the following table: —

LOCALITY.	Distance from Mouth of Concord River. Miles.	Drainage Area. Sq. Miles.	Population (1885).	Population per Square Mile.
Sudbury River, above Dam 1 of the Boston Water Works, including Farm Pond,	36	75.2	24,000	319
Sudbury River, at mouth,	16	164.0	40,401	246
Assabet River, below Northborough,	38.5	30.5	2,838	93
Assabet River, at mouth,	16	176.8	18,650	105
Sudbury and Assabet rivers, at confluence,	16	340.8	59,051	173
Concord River, at Lawrence Street bridge, Lowell,	1.5	376.5	65,101	173
Concord River, at mouth,	0	402.1	-	-

It will be observed from the above table that the population on the Sudbury River watershed is more dense in the upper portion than in the valley as a whole; also that the density of population in this valley is much greater than in the Assabet. A portion of the city of Lowell and many factories discharge sewage into the Concord River at its mouth, so that this portion is more polluted than any other.

The watershed of the Concord above Lowell contains the whole or a considerable portion of 14 towns which drain into the river below the dams of the Boston Water Works. Of these, Concord, Framingham, Maynard, Hudson and Marlborough have public water supplies; and one of them, Framingham, has a system of sewerage for its main village, by which the sewage is purified by filtration before being turned into the stream. The main river, from North Billerica

to its mouth, has large factories upon it, but elsewhere in the valley the factories which discharge much manufacturing waste into the streams are comparatively few. The more important ones are the woolen mills at Saxonville and Maynard.

Examinations of the Assabet River at Northborough have been made monthly for two years, with a view to determining its quality as a possible future source of water supply for Boston or its suburbs. Examinations have also been made for nearly a year of the Concord River above Lowell, and a single examination has been made of the water at the mouth of the river. In addition to these analyses, which are appended, examinations have been made of the surface waters in the basin, and are given in the preceding portion of this report, as follows: —

Boston, Sudbury River and Lake Cochituate, . . pages 38–52
Concord, Warner's Pond, ... page 110
Framingham, Gleason's Pond, ... page 131
Framingham, Learned's Pond, ... page 131
Hudson, Gates Pond, ... page 161
Marlborough, Lake Williams, ... page 219
Maynard, White Pond, ... page 221
Natick, Dug Pond, ... page 234
Northborough, Cold Harbor Brook Reservoir, . . page 258
Sherborn, Waushakum Pond, ... page 291
Wayland, Snake Brook Reservoir, ... page 339
Westborough, Sandra Pond, ... page 348
Westborough, Chauncy Pond, ... page 351

Chemical Examination of Water from the Assabet River below Northborough.

[Parts per 100,000.]

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.
	1887.												
98	June 14	June 15	Slight.	Slight.	0.90	5.37	2.42	2.95	.0032	.0240	.27	.0130	–
311	July 12	July 13	Very slight.	Very slight.	0.60	5.32	1.42	3.90	.0066	.0240	.23	.0130	–
524	Aug. 11	Aug. 12	Slight.	Slight.	0.80	5.35	1.67	3.68	.0061	.0303	.29	.0030	–
744	Sept. 12	Sept. 13	Distinct.	Very slight.	0.50	4.85	1.20	3.65	.0037	.0238	.30	.0030	–
952	Oct. 13	Oct. 14	Distinct.	Sli't, earthy and floc't.	0.65	5.40	1.30	4.10	.0030	.0324	.32	.0100	–
1153	Nov. 10	Nov. 11	Decided.	Very slight.	0.30	5.25	1.05	4.20	.0018	.0212	.31	.0090	–
1397	Dec. 14	Dec. 14	Slight.	Sli't, earthy and floc't.	0.80	4.70	1.45	3.25	.0058	.0238	.27	.0080	–

Chemical Examination of Water from the Assabet River below Northborough — Con.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
1830	Feb. 14	Feb. 15	Very slight.	Sli't, white.	0.60	5.25	1.60	3.65	.0068	.0360	.28	.0180	.0000
2017	Mar. 15	Mar. 16	Slight.	Very slight.	0.40	4.35	1.30	3.05	.0056	.0274	.25	.0100	.0001
2248	Apr. 18	Apr. 19	Slight.	Very slight.	0.50	3.10	1.25	1.85	.0005	.0416	.17	.0100	.0002
2435	May 16	May 17	Slight.	Very slight.	1.40	4.35	2.10	2.25	.0008	.0348	.15	.0050	.0000
2599	June 13	June 14	Very slight.	Slight.	0.70	4.30	1.25	3.05	.0018	.0192 .0192	.12	.0100	.0003
2791	July 18	July 19	Slight.	Very slight.	0.40	4.05	1.20	2.85	.0010	.0230 .0210	.23	.0020	.0002
2949	Aug. 15	Aug. 16	Very slight.	Very slight.	0.40	4.70	0.90	3.80	.0052	.0214 .0174	.26	.0090	.0002
3221	Sept. 19	Sept. 20	Slight.	Slight.	0.60	5.00	2.20	2.80	.0034	.0308 .0258	.25	.0100	.0001
3384	Oct. 17	Oct. 18	Very slight.	Very slight.	1.30	4.35	1.75	2.60	.0002	.0210 .0202	.23	.0080	.0002
3549	Nov. 14	Nov. 15	Very slight.	Very slight.	1.20	4.50	1.60	2.90	.0000	.0238 .0214	.20	.0060	.0000
3702	Dec. 12	Dec. 13	None.	Slight.	0.55	3.55	1.30	2.25	.0000	.0140 .0112	.22	.0080	.0002
	1889.												
3857	Jan. 16	Jan. 17	Very slight.	Very slight.	0.30	3.20	0.85	2.35	.0006	.0142 .0122	.23	.0100	.0002
4049	Feb. 20	Feb. 21	Very slight.	Consid'ble.	0.40	3.60	1.45	2.15	.0012	.0198 .0148	.20	.0100	.0002
4352	Mar. 20	Mar. 21	Very slight.	Very slight.	0.40	3.10	1.20	1.90	.0004	.0190 .0156	.21	.0050	.0002
4525	Apr. 17	Apr. 18	Slight.	Slight.	0.60	3.75	1.55	2.20	.0016	.0222 .0206	.21	.0050	.0001
4671	May 15	May 16	Slight.	Sli't, red'ish brown.	1.00	4.65	1.70	2.95	.0030	.0252 .0235	.19	.0060	.0002
Av.	....	....	....	....	0.67	4.84	1.52	3.32	.0027	.0249	.23	.0083	.0001

Hardness in May, 1888, 1.6. Odor, faintly vegetable. —— The samples were collected from the river at Woods' Mill Pond about one mile below the village of Northborough. No. 98 was collected five feet beneath the surface.

Microscopical Examination.

	1888. June.	1888. July.	1888. Aug.	1888. Sept.	1888. Oct.	1888. Nov.	1888. Dec.	1889. Jan.	1889. Feb.	1889. Mar.	1889. Apr.	1889. May.
1. Blue-green Algæ, ...	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	0.8	1.3	1.7	1.3	0.1	0.0	0.2	0.3	3.4	0.3	0.2	0.6
3. Fungi, ...	0.5	0.3	0.1	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, ...	0.0	3.6	0.8	pr.	0.0	0.0	0.0	0.0	0.1	pr.	0.0	0.3

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Synedra*, *Tabellaria;* Zygnemaceæ. 3. Schizomycetes. 4. Protozoa.

Chemical Examination of Water from the Assabet River at Maynard.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
4336	Mar. 18	Mar. 20	Slight.	Slight.	0.3	3.40	1.15	2.25	.0000	.0166 .0146	.28	.0050	.0002

Odor, faintly vegetable.——The sample was collected from the mill pond of the Assabet Manufacturing Company, just above the bridge at Maynard.

Chemical Examination of Water from the Concord River at Lawrence Street Bridge, Lowell.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
2961	Aug. 16	Aug. 17	Very slight.	Very slight.	0.30	4.85	1.05	3.80	.0034	.0224 .0220	.34	.0050	.0003
3231	Sept. 20	Sept. 21	Very slight.	Sli't, brown.	0.50	5.60	2.00	3.60	.0030	.0310 .0264	.39	.0080	.0007
3401	Oct. 18	Oct. 19	Very slight.	Slight.	1.80	5.30	2.30	3.00	.0002	.0266 .0262	.29	.0080	.0003
3559	Nov. 15	Nov. 16	Slight.	Sli't, brown.	1.00	4.60	1.85	2.75	.0004	.0272 .0224	.29	.0150	.0001
3785	Dec. 20	Dec. 22	Decided.	Con., e'rthy and floc't.	0.40	3.05	1.00	2.05	.0000	.0206 .0142	.19	.0060	.0002
	1889.												
3872	Jan. 17	Jan. 19	Slight, milky.	Very slight.	0.35	3.35	1.10	2.25	.0000	.0148 .0140	.28	.0070	.0003
4088	Feb. 21	Feb. 23	Slight.	Slight.	0.30	5.75	1.45	4.30	.0000	.0138 .0126	.29	.0220	.0004
4372	Mar. 21	Mar. 22	Distinct.	Slight.	0.30	3.55	1.20	2.35	.0000	.0240 .0194	.30	.0050	.0003
4535	Apr. 18	Apr. 19	Distinct.	Slight.	0.70	4.15	1.40	2.75	.0022	.0236 .0222	.31	.0040	.0002
4694	May 18	May 20	Slight.	Consid'ble.	0.90	4.65	1.90	2.75	.0098	.0330 .0254	.30	.0040	.0003
Av.	....	....	....	....	0.65	4.48	1.52	2.96	.0019	.0237 .0205	.30	.0084	.0003

Odor, faintly vegetable and mouldy.——The samples were collected from the river at Lawrence Street bridge, near Bleachery Station, on the Boston and Maine Railroad.

Microscopical Examination.

	1888.					1889.				
	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ,	0.0	pr.	0.0	pr.	0.0	0.0	0.0	pr.	0.0	0.0
2. Other Algæ,	0.1	0.5	pr.	2.4	1.2	1.0	0.2	9.0	2.0	1.3
3. Fungi,	pr.	0.0	0.0	0.0	0.0	pr.	0.0	0.0	0.0	0.0
4. Animal Forms,	pr.	pr.	0.0	1.2	0.4	pr.	0.0	0.2	0.0	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Synedra, Tabellaria;* Zygnemaceæ; Volvocineæ. 3. Schizomycetes. 4. Protozoa, *Dinobryon;* Spongiaria; Rotifera.

Chemical Examination of Water from the Concord River, at its Mouth, in Lowell.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
1214	Nov. 17	Nov. 18	Distinct.	Con., e'rthy and floc't.	0.8	7.05	2.35	4.70	.0074	.0375	.56	.0100	–

Odor, faintly mouldy.—— The sample was collected from the river below the last bridge, and near the lower end of the retaining wall on the south bank.

Connecticut River.

The Connecticut River rises in the Connecticut lakes, in the extreme northern portion of New Hampshire, and flows in a southerly direction, forming the boundary between New Hampshire and Vermont, to the Massachusetts State line; then continues in the same direction through this State and Connecticut, and empties into Long Island Sound. Its basin is long and narrow, the greatest width being about 60 miles, in Massachusetts, while its average width is about 40 miles. The fall of the river in the upper part of its course is very rapid. In Massachusetts the river falls 41 feet at Turner's Falls and 59 feet at Holyoke. These are the only falls in Massachusetts, and both are extensively used for power, the latter being the largest developed water power in the United States. In Connecticut, at Windsor Locks, a short distance below the Massachusetts line, the river falls about 30 feet and reaches tide-water.

Owing to the size of the drainage area and the large amount of storage in it, the summer flow of the river is large. The lowest discharge at Hartford from gaugings from 1871 to 1878 was at the rate of 5,208 cubic feet per second, equal to 0.51 of a cubic foot per second per square mile. The river has since been somewhat lower. The upper portion of the drainage area in New Hampshire and Vermont is mountainous. In Massachusetts, particularly on the easterly side of the basin, mountains give place to ranges of high hills. In the immediate vicinity of the river in this State there are broad intervales. The following table gives statistics of the drainage area and population at three points on the river: —

Locality.	Drainage Area. Sq. Miles.	Population (1880).	Population per Square Mile.
Connecticut River above Turner's Falls,	6,902	217,033	31
Connecticut River above Windsor Locks, Conn.,	9,347	440,641	47
Connecticut River at mouth,	11,269	637,175	56

Note. —— The drainage areas at Turner's Falls and Windsor Locks are taken from the United States Census of 1880, Volume XVI, Water Power. Both the drainage area and the population at the mouth are taken directly from the United States Census of 1880, Volume, Population, p. liv.

It will be seen from this table that the population per square mile above Turner's Falls is very small, and increases at the lower points. It is not, however, high at any point in Massachusetts, as compared with other rivers in the State. The cities of Northampton, Holyoke and Springfield, and the town of Chicopee, which had in 1888 an aggregate population of about 97,000, are located on the river within a distance of 19 miles. These places all discharge their sewage directly into the river or its tributaries; but the volume flowing in the river is so great that the effect is not very noticeable a few miles below Springfield, except by chemical analysis. The stream is, however, too much polluted to permit its use as a source of domestic water supply.

Examinations of the water of the river were made monthly from June, 1887, to May, 1889, above Turner's Falls and below Springfield, and the results are appended. A description of the main tributaries of the Connecticut River in Massachusetts, namely, the Chicopee, Miller's, Westfield and Deerfield rivers, may be found in alphabetical order in this portion of the report.

Chemical Examination of Water from the Connecticut River, above Turner's Falls, in Montague.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.		Nitrates.	Nitrites.
	1887.												
73	June 9	June 11	–	–	0.40	6.30	2.00	4.30	.0064	.0197	.13	.0070	–
282	July 7	July 8	Slight.	Con., brown.	0.40	6.25	1.50	4.75	.0025	.0115	.09	.0030	–
486	Aug. 4	Aug. 6	Slight.	Con., brown.	0.80	6.50	1.55	4.95	.0022	.0180	.08	.0070	–
720	Sept. 7	Sept. 9	Slight.	Sli't, earthy and floc't.	0.25	6.72	0.65	6.07	.0033	.0107	.13	.0070	–
901	Oct. 6	Oct. 8	Distinct.	Slight.	0.30	6.55	0.90	5.65	.0046	.0123	.13	.0090	–
1345	Dec. 5	Dec. 8	Slight.	Con., brown.	0.75	5.50	1.50	4.00	.0025	.0169	.12	.0180	–
	1888.												
1542	Jan. 5	Jan. 6	Slight.	Slight.	0.40	5.15	0.90	4.25	.0000	.0116	.08	.0120	–
1835	Feb. 14	Feb. 15	Slight.	Slight.	0.15	6.10	1.10	5.00	.0028	.0239	.13	.0250	–
2038	Mar. 16	Mar. 19	Slight.	Sli't, white.	0 20	5.65	0.85	4.80	.0000	.0083	.10	.0180	.0001
2216	Apr. 12	Apr. 14	Distinct.	Con. earthy and floc't.	0 10	7 40	1.00	6.40	.0000	.0122	.09	.0100	.0001
2412	May 11	May 14	Distinct.	Con. earthy.	0.30	8.10	1.30	6.80	.0008	.0126	.06	.0120	.0001
2775	July 11	July 14	Slight.	Sli't, white.	0.15	6.10	0.95	5.15	.0020	.0142 .0120	.09	.0020	.0001
2940	Aug. 15	Aug. 16	Slight.	Very slight.	0.20	6.40	1.15	5.25	.0010	.0138 .0118	.10	.0070	.0002
3212	Sept. 18	Sept. 19	Very slight.	Slight.	0.20	5.70	1.15	4.55	.0004	.0126 .0112	.10	.0050	.0002
3375	Oct. 15	Oct. 17	Slight.	Slight.	0.50	5.20	1.30	3.90	.0154	.0152 .0122	.18	.0250	.0018
3593	Nov. 22	Nov. 23	Slight.	Con. earthy and floc't.	0.35	4.75	1.45	3.30	.0032	.0138 .0116	.09	.0150	.0007
3789	Dec. 19	Dec. 22	Decided.	Con. earthy and floc't.	0.25	3.60	0.95	2.65	.0010	.0176 .0126	.07	.0150	.0004
	1889.												
3897	Jan. 21	Jan. 23	Distinct.	He'vy, light brown.	0.20	4.15	0.75	3.40	.0014	.0130 .0068	.10	.0120	.0001
4135	Feb. 25	Feb. 27	Very slight.	Slight.	0.10	5.40	0.70	4.70	.0002	.0070 .0070	.12	.0200	.0001
4419	Mar. 25	Mar. 28	Slight.	Con. earthy and floc't.	0.10	4.10	0.65	3.45	.0006	.0096 .0064	.06	.0150	.0001
4585	Apr. 25	Apr. 27	Distinct.	H'vy, earthy and floc't.	0.30	3.75	1.20	2.55	.0016	.0204 .0128	.04	.0150	.0004
Av.	....	....	....	....	0.30	6.38	1.20	5.18	.0025	.0140	.10	.0123	.0003

Hardness in May, 1888, 2.0. Odor, very faintly vegetable.——The samples were collected from the river above the bridge at Turner's Falls. At the time samples numbered 486, 2412 and 3212 were collected, the river was quite high on account of heavy rains.

Microscopical Examination.

	1888.						1889.			
	July.	Aug.	Sept.	Oct.	Nov	Dec.	Jan.	Feb.	Mar.	Apr.
1. Blue-green Algæ,	0.0	0.0	pr.	pr.	0.0	-	0.0	0.0	0.0	0.0
2. Other Algæ,	37.3	3.6	3.2	1.7	1.1	-	0.2	0.5	0.4	0.6
3. Fungi,	1.5	0.0	pr.	pr.	pr.	-	0.0	0.0	0.0	pr.
4. Animal Forms,	15.6	0.1	pr.	pr.	0.0	-	0.0	0.0	0.1	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ, *Scenedesmus;* Desmidiaceæ; Diatomaceæ, *Navicula, Synedra.* 3. Schizomycetes, *Crenothrix.* 4. Protozoa, *Dinobryon.*

Chemical Examination of Water from the Connecticut River at Holyoke.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
4221	Mar. 5	Mar. 6	Slight.	Slight.	0.1	4.85	0.70	4.15	.0002	.0078 .0064	.12	.0200	.0001

Odor, very faint or none.—The sample was collected from the river above the dam.

Chemical Examination of Water from the Connecticut River below Springfield.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
202	June 25	June 27	Decided.	Much.	0.30	10.95	1.17	9.78	.0030	.0251	.16	.0130	-
396	July 25	July 25	Decided.	Heavy, earthy.	0.50	-	-	-	.0039	.0390	.14	.0130	-
613	Aug. 24	Aug. 26	Decided.	Heavy, earthy.	0.80	-	-	-	.0028	.0285	.11	.0070	-
1060	Oct. 27	Oct. 28	Distinct.	Con., e'rthy and floc't.	0.30	6.00	1.20	4.80	.0061	.0190	.21	.0070	-
1341	Dec. 6	Dec. 7	Distinct.	Con., e'rthy and floc't.	0.40	5.60	1.20	4.40	.0015	.0161	.16	.0150	-
1486	Dec. 27	Dec. 28	Slight.	Sli't, earthy and floc't.	0.35	5.10	1.00	4.10	.0110	.0176	.19	.0120	-
	1888.												
1689	Jan. 25	Jan. 26	Decided.	Sli't, e'rthy.	0.40	7.00	1.45	5.55	.0253	.0271	.22	.0370	.0001
1812	Feb. 13	Feb. 14	Distinct.	Con., e'rthy and floc't.	0.30	6.15	1.35	4.80	.0274	.0204	.34	.0250	.0005

Chemical Examination of Water from the Connecticut River below Springfield — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
2049	Mar. 19	Mar. 20	Distinct.	Slight.	0.25	4.35	0.55	3.80	.0058	.0136	.18	.0150	.0003
2213	Apr. 13	Apr. 14	Distinct.	Con., e'rthy and floc't.	0.20	6.90	1.40	5.50	.0036	.0235	.15	.0150	.0003
2644	June 20	June 21	Distinct.	Con., white.	0.40	5.10	1.05	4.05	.0056	.0174 .0132	.11	.0090	.0001
2774	July 12	July 14	Slight.	Slight.	0.15	6.60	0.75	5.85	.0016	.0184 .0146	.16	.0050	.0002
2994	Aug. 20	Aug. 21	Slight.	Slight.	0.15	5.85	0.75	5.10	.0052	.0224 .0170	.19	.0050	.0004
3225	Sept. 19	Sept. 20	Distinct.	Con., e'rthy and floc't.	0.30	5.40	1.50	3.90	.0026	.0196 .0156	.15	.0070	.0002
3404	Oct. 18	Oct. 19	Distinct.	Con., e'rthy and floc't.	0.60	4.45	1.60	2.85	.0012	.0140 .0118	.10	.0080	.0003
3585	Nov. 21	Nov. 22	Distinct.	Con., e'rthy and floc't.	0.50	4.65	1.80	2.85	.0032	.0172 .0134	.18	.0150	.0002
3764	Dec. 17	Dec. 20	Decided.	H'vy, e'rthy and floc't.	0.40	3.35	1.00	2.35	.0028	.0216 .0138	.10	.0120	.0003
	1889.												
3913	Jan. 23	Jan. 24	Sli't, milky.	Sli't, e'rthy.	0.20	3.85	1.20	2.65	.0044	.0142 .0120	.16	.0150	.0003
4151	Feb. 27	Feb. 28	Distinct.	Sli't, earthy and floc't.	0.20	5.45	1.25	4.20	.0206	.0208 .0168	.34	.0220	.0008
4416	Mar. 27	Mar. 28	Slight.	H'vy, e'rthy and floc't.	0.20	4.20	0.95	3.25	.0094	.0186 .0136	.12	.0150	.0002
4739	May 24	May 25	Distinct.	Con., e'rthy.	0.40	5.30	1.75	3.55	.0076	.0248 .0212	.19	.0090	.0007
Av.	....	....	....	....	0.35	6.51	1.16	5.35	.0074	.0209	.17	.0134	.0003

Odor, faintly vegetable and mouldy. —— The samples were collected from the river at the south end bridge below Springfield. There were heavy rains just previous to the collection of the first three samples.

Microscopical Examination.

	1888. June.	1888. July.	1888. Aug.	1888. Sept.	1888. Oct.	1888. Nov.	1888. Dec.	1889. Jan.	1889. Feb.	1889. Mar.	1889. May.
1. Blue-green Algæ, ...	pr.	pr.	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	7.3	2.2	1.4	1.4	0.4	0.4	15.6	pr.	0.1	1.3	10.9
3. Fungi, ...	0.0	5.0	0.1	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, ...	pr.	0.4	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ, *Scenedesmus;* Desmidiaceæ; Diatomaceæ; *Melosira, Synedra.* 3. Schizomycetes, *Crenothrix.* 4. Protozoa; Entomostraca.

Deerfield River.

The Deerfield River rises in Stratton, Vt., 25 miles north of the Massachusetts State line, and flows in a generally southerly direction to a point opposite the mouth of Hoosac Tunnel, where it curves to the east and flows in a circuitous course to the Connecticut River, opposite Turner's Falls. The watershed is rugged and mountainous, and the fall of the river very rapid throughout nearly all of its course. There are very few ponds on the watershed, and the flow of the river is subject to great fluctuations.

A careful examination of the Deerfield River was made by the State Board of Health, Lunacy, and Charity in 1880, the results of which may be found in the supplementary report of the Board for that year (pp. 3–11).

This examination showed that the river was not much polluted in 1880, and as there has been but little change in the amount of population or manufacturing in the valley since that date, the river has not been re-examined. A summary of the results then obtained is given below.

Drainage area at mouth of river, 660 square miles. Population on drainage area in 1880, 23,951. Population per square mile in 1880, 36.

MANUFACTURES.	Number.	Operatives employed.
Woolen mills,	1	112
Cotton mills,	7	484
Tanneries,	6	60
Cutlery works,	3	390
Machine shops and foundries,	6	245
Gas works,	1	2
Totals,	24	1,293

Hoosac River.

The Hoosac basin occupies the north-western corner of the State, and its drainage area above where it crosses the State line into Vermont is 195 2 square miles. The main river is formed at North Adams by the confluence of the north and south branches, and flows

thence in a generally north-westerly course, and finally empties into the Hudson River opposite Stillwater, in New York. The south branch rises in Cheshire and Lanesborough, and flows in a northerly direction to its confluence with the north branch at North Adams. At its head is located the Cheshire Reservoir, said to have an area of from 600 to 700 acres. The reservoir can be drawn down from seven to eight feet, and is used to increase the flow of this branch in dry seasons. The north branch rises in Vermont, and flows with a rapid fall in a southerly and south-westerly direction to the confluence. There is a reservoir on this branch in the town of Clarksburg, having an area of 44 acres, which can be drawn down eight feet.

On the main stream there are four dams within the State of Massachusetts, at which there is a total fall of 64 feet.

The south branch and main stream flow through a broad valley, not much above the river and generally under cultivation.

Outside of these valleys the watershed in Massachusetts is rugged and mountainous, the steep slopes being generally well wooded. Limestone is abundant, and, as a consequence, the waters of this basin are generally much harder than those in the easterly section of the State.

Nearly all of the population of the valley in Massachusetts is in four towns, as follows : —

TOWN.	POPULATION.	
	1880.	1885.
North Adams,	10,191	12,540
Adams,	5,591	8,283
Williamstown,	3,394	3,729
Cheshire,	1,537	1,448
Total,	20,713	26,000

All of these towns have public water supplies, but none are completely sewered. North Adams has the largest number of sewers, and turns a large and increasing amount of sewage directly into the river; and the many large factories on the stream generally adopt the same method of disposing of their wastes.

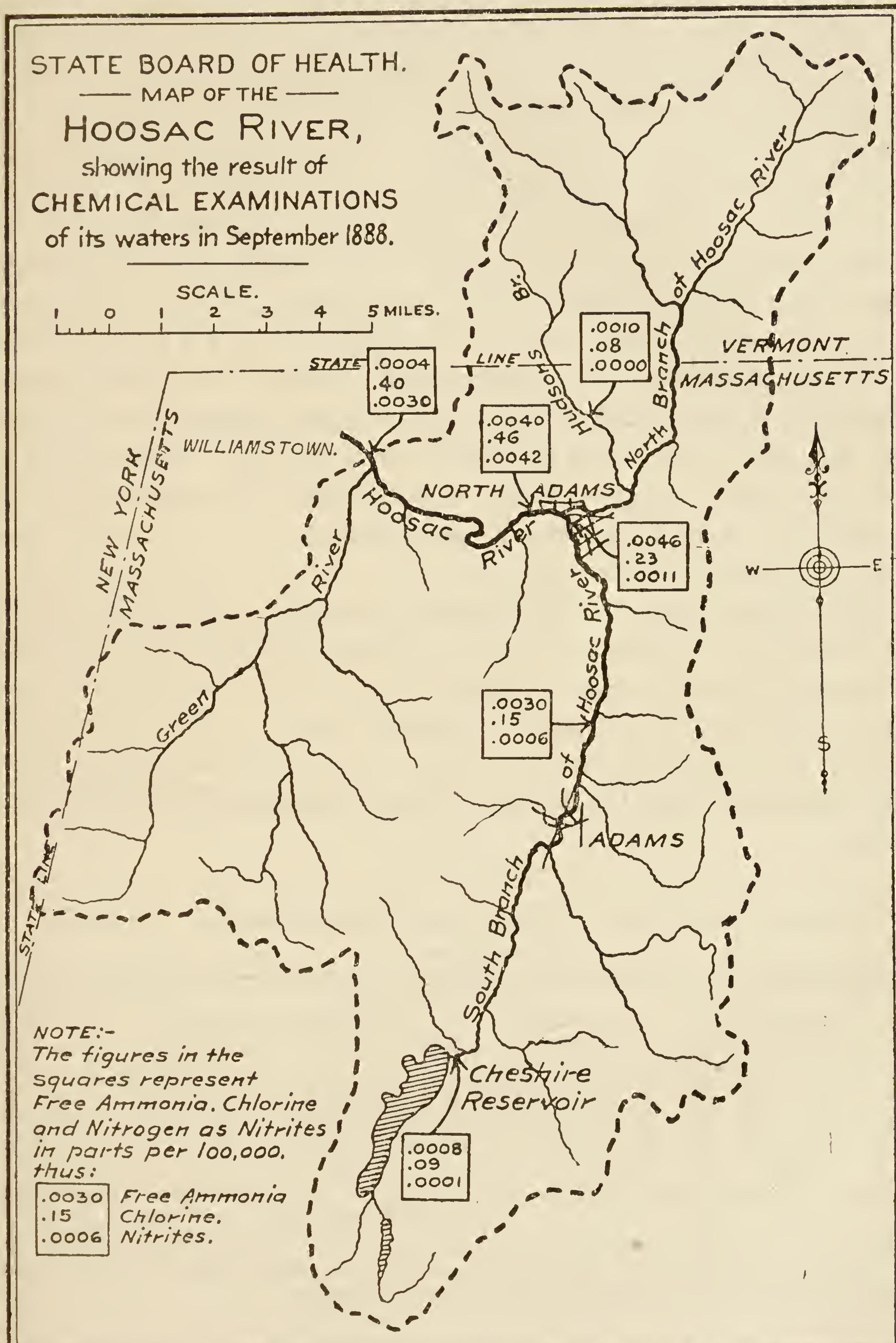
The following table gives statistics in relation to drainage areas and population at different points on the main stream and its branches : —

Locality.	Distance above State Line. Miles.	Drainage Area. Sq. Miles.	Population (1885).	Population per Square Mile.
South Branch, about two miles below Adams, just at end of tail race from mill of Renfrew Manuf'g Co.,	13.7	62.7	10,023	160
South Branch, at bridge, about two miles south of North Adams, ...	11.2	67.2	–	–
South Branch, at mouth, ...	–	74.3	–	–
North Branch, at mouth, ...	–	42.4	–	–
Total at confluence, ...	7.7	116.7	–	–
Hoosac River, at Braytonville, North Adams, . .	7.0	117.5	23,130	197
Hoosac River, at Williamstown, ...	2.8	175.5	26,758	152

An examination of the Hoosac Valley was made by the State Board of Health in 1877, and printed in the ninth annual report of the Board (pp. 28–38). The following table, containing a summary of the manufactures in the Hoosac basin at that date, is taken from page 35 of that report : —

Manufactures.	Number.	Operatives Employed.
Cotton mills, ...	17	2,099
Woolen mills, ...	6	900
Paper mills, ...	3	210
Tanneries, ...	3	21
Gas works, ...	2	6
Acid works, ...	2	14
Print works, ...	2	463
Totals, ...	35	3,713

Examinations of samples of water collected from the river at Williamstown were made monthly from June, 1887, to May, 1889. A special examination was also made of the river at several points in September, 1888. The results of all of these examinations are given in the appended tables of analyses, and the results of the


STATE BOARD OF HEALTH.
MAP OF THE
HOOSAC RIVER,
showing the result of
CHEMICAL EXAMINATIONS
of its waters in September 1888.
SCALE.
1 0 1 2 3 4 5 MILES.
STATE LINE
VERMONT
MASSACHUSETTS
NEW YORK
MASSACHUSETTS
WILLIAMSTOWN.
NORTH ADAMS
ADAMS
Hoosac River
Green River
Hudson's Br.
North Branch of Hoosac River
South Branch of Hoosac River
Cheshire Reservoir
STATE LINE
.0004 .40 .0030
.0010 .08 .0000
.0040 .46 .0042
.0046 .23 .0011
.0030 .15 .0006
.0008 .09 .0001
W E S
NOTE:- The figures in the squares represent Free Ammonia. Chlorine and Nitrogen as Nitrites in parts per 100,000. thus:
.0030 Free Ammonia
.15 Chlorine.
.0006 Nitrites.

special examination are also indicated on the map on page 423, which shows by the figures in the squares the amount of free ammonia, chlorine, and nitrogen as nitrites. It will be seen that there is a progressive increase in the amount of these constituents as a result of the sewage and factory wastes turned into the stream at Adams and North Adams. This increase of contamination, however, does not continue as far as Williamstown, the character of the river water at this place being better than just below North Adams, a result due in part to the dilution of the polluted water by the purer water of the Green River. On the day after this special examination, between the hours of 3 and 4 P.M., the flow of the south branch, at a point between Adams and North Adams, where the drainage area is 67.2 square miles, was measured with a current meter, and found to be 97.5 cubic feet per second, equal to 1.4 cubic feet per second per square mile. No opportunity was found for making a trustworthy measurement at this time on either the north branch or the main river.

The Hoosac River at Williamstown is shown by the analyses to be polluted to a considerable extent, although not so much as might be expected from its dark appearance, which is caused for the most part by the spent dye liquors discharged into it. The pollution is rapidly increasing, however, owing to the increase of population and manufacturing, the sewage being discharged directly into the stream.

Chemical Examination of Water from Cheshire Reservoir in Cheshire.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1888.												
3281	Sept. 27	Sept. 28	Distinct.	Sli't, brown.	0.2	8.35	1.90	6.45	.0008	.0262 .0190	.09	.0030	.0001

Odor, faintly earthy.——The sample was collected from the Cheshire reservoir near the outlet. This reservoir is at the head of the south branch of the Hoosac River.

Microscopical Examination.

September, 1888. 1. Blue-green algæ, pr.; 2. Other algæ, 0.5; 3. Fungi, 0.0; 4. Animal forms, 0.6.

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Zoosporeæ; Diatomaceæ; Desmidiaceæ. 4. Protozoa.

Chemical Examination of Water from the South Branch of the Hoosac River at Renfrew, between Adams and North Adams.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1888.												
3059	Sept. 4	Sept. 6	Slight.	Con., dark.	0.20	11.95	1.45	10.50	.0032	.0274 .0158	.16	.0200	.0006
3060	Sept. 4	Sept. 6	Slight.	Sli't, dark.	0.20	12.55 11.45	1.70 1.55	10.85 9.90	.0054	.0248 .0152	.16	.0180	.0006
3061	Sept. 4	Sept. 6	Slight.	Sli't, dark.	0.35	11.90	1.55	10.35	.0022	.0226 .0152	.14	.0220	.0006
3062	Sept. 4	Sept. 6	Slight.	Sli't, dark.	0.20	11.90	1.85	10.05	.0010	.0248 .0154	.14	.0120	.0006
Av.	....	....	....	....	0.24	11.80	1.60	10.20	.0030	.0249 .0154	.15	.0180	.0006

Hardness of all samples, 10.4. Odor, very faintly vegetable.—— The samples were collected from the south branch of the Hoosac River, just below the outlet of the tail race from the Renfrew Manufacturing Company's mill, each sample being collected from many points in the width of the stream. Samples were collected in the order of the numbers at 2, 3, 4.15, and 5 P.M.

Chemical Examination of Water from the South Branch of the Hoosac River, at its Confluence with the North Branch in North Adams.

[Parts per 100.000]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1888.												
3063	Sept. 4	Sept. 6	Slight.	Con., dark brown.	0.10	15.20 13.10	2.15 1.80	13.05 11.30	.0104	.0186 .0118	.22	.0350	.0012
3064	Sept. 4	Sept. 6	Slight.	Con., dark brown.	0.10	13.05	1.90	11.15	.0042	.0182 .0124	.22	.0400	.0007
3065	Sept. 4	Sept. 6	Slight.	Con., dark brown.	0.10	12.95	1.95	11.00	.0016	.0176 .0132	.21	.0320	.0006
3066	Sept. 4	Sept. 6	Slight.	Con., dark brown.	0.15	12.85	2.15	10.70	.0022	.0196 .0118	.28	.0330	.0018
Av.	....	....	....	....	0.11	12.99	1.95	11.04	.0046	.0185 .0123	.23	.0350	.0011

Hardness of all samples, 11.3. Odor, faintly vegetable, somewhat disagreeable.—— The samples were collected from the canal leading to the mill of the Johnson Manufacturing Company, in the order of their numbers, at 10.45 A.M., 1.45, 3.15, and 4.50 P.M.

Chemical Examination of Water from Hudson Brook in Clarksburg.

[Parts per 100,000.]

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.
	1888.												
2819	July 21	July 23	None.	Slight.	0.1	3.10	0.65	2.45	.0010	.0074 .0046	.08	.0100	.0000

Odor, faintly vegetable.——The sample was collected from the brook.

Microscopical Examination.

July, 1888. 1. Blue-green algæ, 0.0; 2. Other algæ, 2.5; 3. Fungi, 0.0; 4. Animal forms, 0.0. Groups and principal genera of organisms observed: 2. Zoosporeæ; Diatomaceæ, *Achnanthidium*.

Chemical Examination of Water from the Hoosac River, below the Confluence of the North and South Branches at North Adams.

[Parts per 100,000.]

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.
	1888.												
3067	Sept. 4	Sept. 6	Decided.	Con , dark brown.	0.25	14.35	2.60	11.75	.0112	.0362 .0212	.49	.0200	.0010
3068	Sept. 4	Sept. 6	Decided.	Con., dark brown.	0.20	15.70 14.15	2.05 2.00	13.65 12.15	.0002	.0308 .0172	.37	.0200	.0020
3069	Sept. 4	Sept. 6	Decided.	Con., purple brown.	0.50	15.35	2.50	12.85	.0024	.0448 .0214	.49	.0230	.0090
3070	Sept. 4	Sept. 6	Decided.	Consid'ble, brown.	0.50	14.95	2.95	12.00	.0022	.0462 .0234	.49	.0050	.0048
Av.	....	....	....	....	0.36	14.70	2.51	12.19	.0040	.0395 .0208	.46	.0170	.0042

Hardness, 10 5. Odor, peculiar.——The samples were collected from the canal leading to the Braytonville Mills, in the order of their numbers, at 11.15, A.M., 2.15, 3.45, and 5.05 P.M.

Chemical Examination of Water from the Hoosac River at Williamstown.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance: Turbidity.	Appearance: Sediment.	Appearance: Color.	Residue on Evaporation: Total.	Residue on Evaporation: Loss on Ignition.	Residue on Evaporation: Fixed.	Ammonia: Free.	Ammonia: Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
57	June 8	June 9	Decided.	Consid'ble.	0.20	10.75	1.62	9.13	.0026	.0216	.19	.0130	–
279	July 7	July 8	Decided.	Consid'ble.	0.40	11.45	1.60	9.85	.0059	.0222	.22	.0070	–
491	Aug. 6	Aug. 8	Decided.	Consid'ble.	0.30	11.75	0.80	10.95	.0106	.0118	.21	.0330	–
753	Sept. 12	Sept. 14	Slight.	Slight.	0.05	11.45	0.50	10.95	.0065	.0135	.21	.0260	–
888	Oct. 3	Oct. 6	Slight.	Sli't, e'rthy.	0.20	12.70	1.23	11.47	.0132	.0242	.26	.0330	–
1106	Nov. 3	Nov. 5	Decided.	Con., e'rthy and floc't.	0.20	14.22	1.57	12.65	.0005	.0206	.29	.0270	–
1402	Dec. 9	Dec. 15	Distinct.	Con., e'rthy and floc't.	0.10	8.20	1.30	6.90	.0008	.0106	.17	.0280	–
	1888.												
1574	Jan. 6	Jan. 11	Slight.	Con., black.	0.05	9.65	2.15	7.50	.0017	.0237	.26	.0480	.0003
1734	Feb. 1	Feb. 2	Decided, milky.	Con., e'rthy and floc't.	0.10	12.35	2.15	10.20	.0097	.0226	.33	.0450	.0017
1964	Mar. 5	Mar. 7	Distinct, milky.	Slight.	0.10	9.75	1.00	8.75	.0088	.0146	.18	.0460	.0003
2171	Apr. 9	Apr. 10	Decided.	Con., e'rthy.	0.05	6.90	0.65	6.25	.0014	.0062	.08	.0250	.0002
2348	May 2	May 3	Distinct.	Con., e'rthy and floc't.	0.10	6.55	0.95	5.60	.0000	.0112	.10	.0200	.0000
2551	June 5	June 6	Very slight.	Con., brown.	0.00	9.02	1.05	7.97	.0004	.0138 .0098	.17	.0280	.0007
2699	July 2	July 3	Distinct.	Con., brown.	0.10	12.80	2.05	10.75	.0044	.0226 .0174	.33	.0180	.0012
2888	Aug. 6	Aug. 7	Slight.	Sli't, e'rthy.	0.30	11.45	2.95	8.50	.0080	.0282 .0204	.38	.0220	.0023
3135	Sept. 7	Sept. 10	Slight.	Consid'ble, brown.	0.15	15.15	2.20	12.95	.0004	.0282 .0172	.40	.0400	.0030
3318	Oct. 6	Oct. 8	Distinct.	Much, e'rthy and floc't.	0.10	8.50	1.65	6.85	.0024	.0200 .0114	.22	.0200	.0008
3500	Nov. 6	Nov. 7	Distinct.	Slight.	0.10	8.00	1.50	6.50	.0000	.0134 .0092	.15	.0200	.0012
3717	Dec. 14	Dec. 15	Decided.	Con., white.	0.03	12.45	1.55	10.90	.0112	.0194 .0148	.26	.0350	.0006
	1889.												
3829	Jan. 7	Jan. 8	Decided.	Con., e'rthy and floc't.	0.05	7.05	0.80	6.25	.0052	.0136 .0066	.13	.0250	.0002
3974	Feb. 4	Feb. 6	Distinct, milky.	Con., e'rthy.	0.05	9.70	1.10	8.60	.0068	.0140 .0086	.17	.0500	.0003
4217	Mar. 4	Mar. 5	Decided.	Heavy, gray.	0.05	10.35	1.45	8.90	.0182	.0186 .0130	.23	.0200	.0005
4439	Mar. 30	Apr. 1	Slight.	Con., gray.	0.10	6.25	0.95	5.30	.0004	.0136 .0080	.10	.0120	.0004
4649	May 11	May 13	Distinct.	Heavy.	0.15	10.35	1.60	8.75	.0050	.0212 .0158	.25	.0200	.0018
Av.	....	....	....	....	0.13	10.48	1.29	9.19	.0052	.0179	.22	.0275	.0009

Hardness in June, 1887, 7.3; in May, 1888, 3.9. Odor, faintly vegetable and mouldy. —— The samples were collected from the river at the bridge near the Williamstown station on the Fitchburg Railroad.

Microscopical Examination.

	1888.							1889.					
	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Mar.	May.
1. Blue-green Algæ,	0.0	pr.	0.3	0.0	0.0	pr.	pr.	0.0	pr.	0.0	0.0	0.0
2. Other Algæ,	23.4	9.4	7.6	1.6	pr.	0.5	0.3	0.1	0.7	pr.	0.5	6.7
3. Fungi,	9.0	0.3	0.0	0.5	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms,	pr.	0.3	4.0	0.1	0.0	pr.	0.0	0.0	0.3	0.0	0.0	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ, *Chlorococcus;* Zoosporeæ, *Conferva, Scenedesmus;* Desmidiaceæ; Diatomaceæ, *Encyonema, Melosira, Navicula, Stephanodiscus, Synedra.* 3. Schizomycetes, *Crenothrix.* 4. Protozoa, *Trachelomonas.*

Housatonic River.

The Housatonic basin is in the south-westerly corner of the State, and includes the central and southern portion of Berkshire County. The river is formed just below the town of Pittsfield by the confluence of the east and west branches, and flows thence in a southerly direction, passing into Connecticut at Sheffield, Mass., and finally emptying into Long Island Sound near Bridgeport, Conn. The drainage area of the river at the State line is 503.5 square miles. The east branch at its mouth has a drainage area of 70.3 square miles. It rises eight miles south-east of Pittsfield, and flows in a very circuitous course to the main river, passing on its way through the manufacturing towns of Hinsdale and Dalton. The west branch is formed by the flow from Onota and Pontoosuc lakes in Pittsfield, and flows southerly through the westerly portion of the town. The south-west branch, one of the affluents of the west branch, rises in Richmond Lake in Richmond, and flows north-easterly, joining the west branch just above its mouth. The watershed of the west branch, including the south-west branch, contains 58.7 square miles.

The drainage area of the river is, as a rule, very hilly, and in many places even mountainous. The bottom lands along the river are quite wide, and in the vicinity of Pittsfield and south of Great Barrington there is considerable comparatively flat territory. There are many lakes in the valley and some storage reservoirs, which materially increase the flow of the river in a dry season. This valley, like the Hoosac, contains much limestone, and the water of the river is consequently much harder than that of the more easterly portions of the State.

The river and its branches have generally a rapid fall; but there are notable exceptions to this rule in the portion between Pittsfield and Lenox, where the river is nearly level for eight miles; also south of Great Barrington, where a similar condition exists.

The following table gives statistics regarding the drainage area and population above different points on the main river and its branches: —

LOCALITY.	Distance above State Line. Miles.	Drainage Area. Sq. Miles.	Estimated Population (1885).	Population per Square Mile.
East branch, at first bridge above Silver Lake, Pittsfield,	48.0	68.2	4,951	73
East branch, at mouth,	46.0	70.3	9,090	129
Pontoosuc Lake, at outlet,	50.7	21.4	815	38
Onota Lake, at outlet,	50.2	10.5	261	25
South-west branch, at mouth,	46.8	22.2	1,660	75
Total west branch, at mouth,	46.0	58.7	10,110	172
Total east and west branches, at confluence,	46.0	129.0	19,200	149
Housatonic River, at Lenox station,	38.0	167.7	20,496	122
Housatonic River, below Great Barrington,	14.9	328.7	35,067	107

The greatest density of population shown by the table is above the mouth of the west branch, and this tributary is more polluted than the others or than the main stream. The density of population on the area draining into the main river is greatest above its head, just below Pittsfield, where the population per square mile is 40 per cent. greater than it is above a point just below Great Barrington.

The towns of Hinsdale, Dalton, Pittsfield, Lenox, Lee, Stockbridge and Great Barrington have each a public water supply. Pittsfield and Great Barrington have each a partial system of sewerage, and discharge crude sewage into the streams. The village of Lenox has a complete system of sewerage, and disposes of most of its sewage upon land. The population in the valley is slowly increasing, the gain in Pittsfield and the manufacturing villages along the river more than offsetting the decrease in the farming population on the hills.

Most of the fall of the Housatonic River and its principal branches is utilized for power by paper and woolen mills, which turn a considerable amount of manufacturing sewage into the stream.

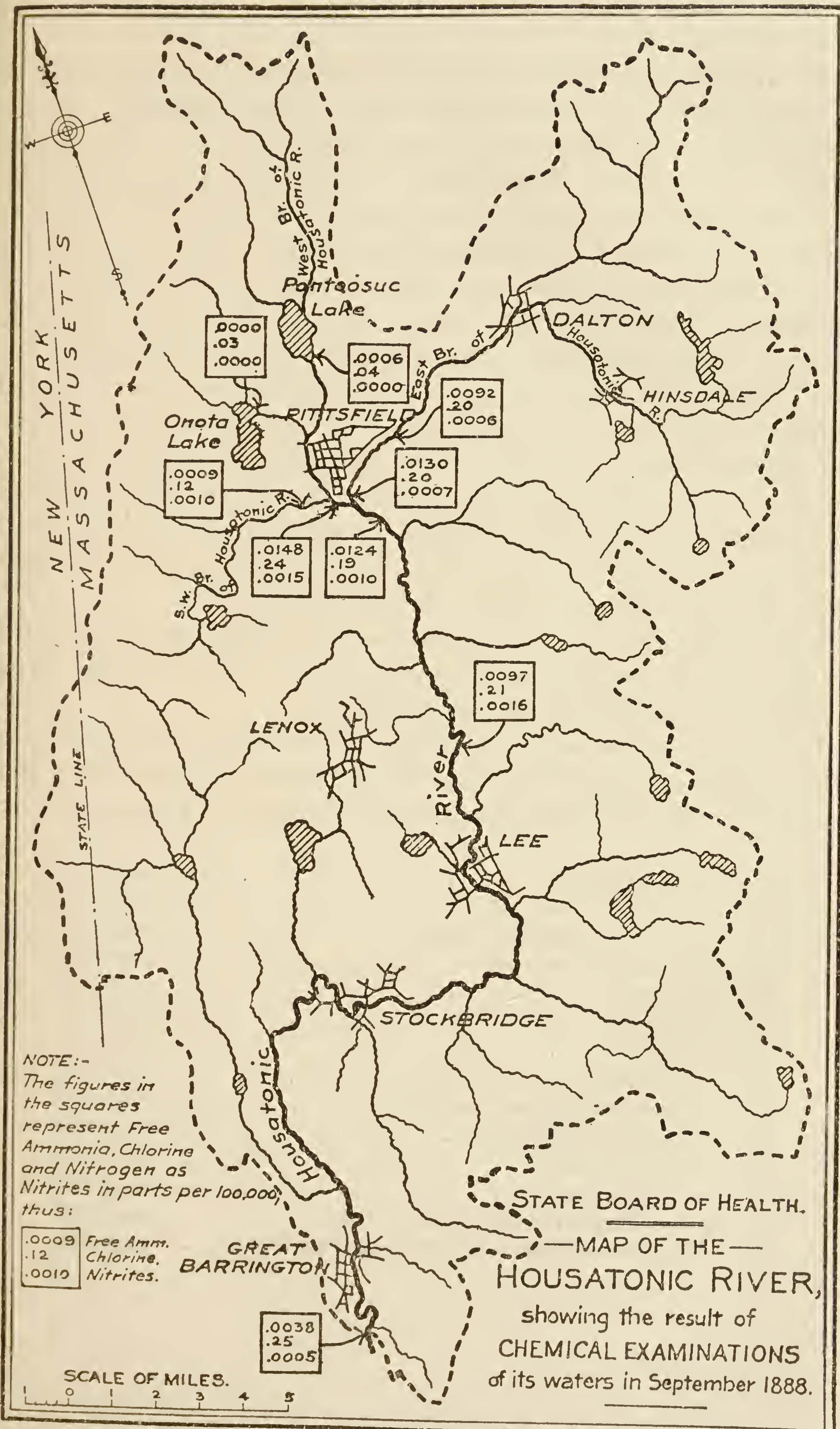
A careful examination of the watershed of the Housatonic River was made by the State Board of Health in 1877, and the results are published in its ninth annual report (pp. 9–28). The following summary of the manufacturing in the valley at that time is taken from page 18 of that report: —

MANUFACTURES.	Number.	Operatives employed.
Woolen mills,	20	2,178
Cotton mills,	6	405
Paper mills,	34	1,401
Tannery,	1	30
Gas works,	1	5
Totals,	62	4,019

Examinations of samples of water from the river were made monthly from June, 1887, to May, 1889, just below the village of Great Barrington; and a special examination was made in September, 1888, during a comparatively dry period, to ascertain the effect of the sewage and manufacturing refuse turned into the river at Pittsfield. For this purpose samples of water were collected from the east and west branches both above and below Pittsfield, from the south-west branch near its mouth, and from the main stream at its head, and at Lenox, eight miles below. The analyses of these samples of water are given in full in the appended tables, and the average amount of free ammonia, chlorine, and nitrogen as nitrites at each point is also shown on the map on page 431.

The flow of each stream at the time samples were collected on Sept. 7, 1888, as deduced from gauge readings on that day, and current meter measurements and gauge readings on the previous day, was as follows: —

East Branch.	West Branch.
Flow at 10.05 A.M., 56.14 cubic feet per second.	Flow at 9.45 A.M., 36.40 cubic feet per second.
Flow at 12.00 M., 67.87 cubic feet per second.	Flow at 11.45 A.M., 67.03 cubic feet per second.
Flow at 3.45 P.M., 79.42 cubic feet per second.	Flow at 3.10 P.M., 73.33 cubic feet per second.
Flow at 4.45 P.M., 79.42 cubic feet per second.	Flow at 5.25 P.M., 90.06 cubic feet per second.



NEW YORK
MASSACHUSETTS
STATE LINE
West Br. of Housatonic R.
Pontoosuc Lake
Onota Lake
PITTSFIELD
East Br. of
DALTON
Housatonic R.
HINSDALE
Housatonic R.
S.W. Br. of Housatonic
LENOX
River
LEE
STOCKBRIDGE
Housatonic
GREAT BARRINGTON
.0000 .03 .0000
.0006 .04 .0000
.0092 .20 .0006
.0130 .20 .0007
.0009 .12 .0010
.0148 .24 .0015
.0124 .19 .0010
.0097 .21 .0016
.0038 .25 .0005
NOTE:- The figures in the squares represent Free Ammonia, Chlorine and Nitrogen as Nitrites in parts per 100,000, thus:
.0009 Free Amm.
.12 Chlorine.
.0010 Nitrites.
SCALE OF MILES.
1 0 1 2 3 4 5
STATE BOARD OF HEALTH.
—MAP OF THE—
HOUSATONIC RIVER,
showing the result of
CHEMICAL EXAMINATIONS
of its waters in September 1888.

These measurements do not indicate an unusually low dry weather flow.

The special examination of the river on Sept. 7, 1888, showed that it was polluted to a considerable extent below Pittsfield, though not enough to be offensive to those living on the banks of the stream. The effect of the pollution is most plainly seen by referring to the map, and observing the much larger amounts of free ammonia, chlorine and nitrogen as nitrites in the water at the mouth of the west branch than in the unpolluted waters of Lakes Onota and Pontoosuc, from which this branch issues. The west branch is shown by this examination to be somewhat more polluted than the east branch. The degree of pollution of the former is much greater during the night and on Sundays, in dry seasons, than during working hours, because the water is held back by gates at the outlets of the lakes and at the mill ponds on the stream, so that the flow at such times is very small. The east branch, being a "paper-mill" stream, with comparatively little opportunity to hold the water back, has a nearly constant flow day and night.

The regular examinations below Great Barrington show the water at this point to be unfit for drinking, though except for this use it would not be considered seriously polluted.

In addition to the tables of analyses given below, examinations of other surface waters in the Housatonic basin have been made, and are given in the preceding portion of this report, as follows: —

Dalton, Egypt Brook, ... page 111
Great Barrington, reservoir, ... page 141
Great Barrington, Mansfield Lake, ... page 142
Great Barrington, Green River, ... page 142
Hinsdale, brook, ... page 152
Lee, reservoir, ... page 184
Lenox, reservoir, ... page 186
Lenox, Lily Pond, ... page 186
Pittsfield, Ashley Lake and reservoir, . . . pages 268-269
Pittsfield, Sackett Reservoir, ... page 269
Pittsfield, Silver Lake, ... page 271
Richmond, reservoir, ... page 285
Stockbridge, Hagar Pond or Mohawk Lake, . . . page 307
Stockbridge, Lake Mahkeenac or Stockbridge Bowl, . page 308

Chemical Examination of Water from the East Branch of the Housatonic River above Hinsdale.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
3983	Feb. 6	Feb. 7	Slight.	Consid'ble.	0.2	5.40	1.15	4.25	.0036	.0138 .0110	.08	.0180	.0001

Hardness, 3.3. Odor, very faintly vegetable.—— The sample was collected from the river just above the village of Hinsdale.

Microscopical Examination.

1. Blue-green algæ, 0.0; 2. Other algæ, 0.3; 3. Fungi, 0.0; 4. Animal forms, pr.
Groups of organisms observed: 2. Diatomaceæ. 4. Protozoa.

Chemical Examination of Water from the East Branch of the Housatonic River above Pittsfield.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
3111	Sept. 7	Sept. 8	Slight.	Sli't, brown.	0.2	11.20	1.50	9.70	.0092	.0238 .0202	.19	.0180	.0008
3125	Sept. 7	Sept. 8	Distinct.	Con., dark.	0.2	11.75	2.40	9.35	.0092	.0390 .0364	.20	.0200	.0003
Av.	....	....	....	....	0.2	11.47	1.95	9.52	.0092	.0314 .0283	.20	.0190	.0006

Odor, mouldy.—— The samples were collected from the Housatonic River at the first bridge above Silver Lake. No. 3111 was collected at 9 A.M. No. 3125 was collected at 5 P.M.

Chemical Examination of Water from the East Branch of the Housatonic River below Pittsfield.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.		Nitrates.	Nitrites.
	18	88.											
3113	Sept. 7	Sept. 8	Slight.	Sl't, brown.	0.2	11.30	2.20	9.10	.0180	.0246 .0210	.20	.0250	.0009
3118	Sept. 7	Sept. 8	Distinct.	Sl't, brown.	0.2	11.10	2.05	9.05	.0120	.0252 .0224	.20	.0070	.0008
3122	Sept. 7	Sept. 8	Slight.	Slight.	0.2	11.15	2.05	9.10	.0116	.0212 .0210	.20	.0150	.0008
3124	Sept. 7	Sept. 8	Slight.	Slight.	0.2	11.20	2.20	9.00	.0102	.0216 .0194	.19	.0220	.0003
Av.	....	....	....	....	0.2	11.19	2.12	9.07	.0130	.0231 .0210	.20	.0172	.0007

Odor, mouldy. —— The samples were collected from the river at several points in the width of the stream, at the first bridge above its confluence with the west branch, as follows: No. 3113, at 10.05 A.M.; No. 3118, at 12 M.; No. 3122, at 3.45 P.M.; No. 3124, at 4.45 P.M.

Chemical Examination of Water from Lake Onota, Pittsfield.

[Parts per 100,000]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.		Nitrates.	Nitrites.
	18	88.											
3115	Sept. 7	Sept. 8	Very slight.	Very slight.	0.0	6.60	1.45	5.15	.0000	.0158 .0110	.03	.0030	.0000

Odor, none. —— The sample was collected from the east side of the lake.

Chemical Examination of Water from Pontoosuc Lake, Pittsfield.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.		Nitrates.	Nitrites.
	18	88.											
3123	Sept. 7	Sept. 8	Very slight.	Very slight.	0.0	7.90	0.80	7.10	.0006	.0128 .0122	.04	.0000	.0000

Odor, none. —— The sample was collected from the lake at the outlet.

Chemical Examination of Water from the South-west Branch of the Housatonic River, near its Confluence with the West Branch.

[Parts per 100,000.]

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.	Chlorine.	Nitrates.	Nitrites.
	1888.												
3116	Sept. 7	Sept. 8	Distinct.	Con.,e'rthy and floc't.	0.10	14.60	2.65	11.95	.0010	.0198 .0150	.12	.0180	.0010
3120	Sept. 7	Sept. 8	Slight.	Slight.	0.05	13.45	1.75	11.70	.0008	.0178 .0156	.12	.0120	.0009
Av.	....	....	....	....	0.07	14.02	2.20	11.82	.0009	.0188 .0153	.12	.0150	.0010

Odor, faintly vegetable. —— The samples were collected from the stream, just above its confluence with the west branch of the Housatonic River, at 11.30 A.M. and 3 P.M. respectively.

Chemical Examination of Water from the West Branch of the Housatonic River below Pittsfield.

[Parts per 100,000.]

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.	Chlorine.	Nitrates.	Nitrites.
	1888.												
3112	Sept. 7	Sept. 8	Slight.	Sl't,brown.	0.05	11.60	1.60	10.00	.0228	.0326 .0250	.22	.0230	.0020
3117	Sept. 7	Sept. 8	Distinct.	Con.,brown.	0.10	11.10	2.05	9.05	.0194	.0380 .0230	.33	.0080	.0015
3121	Sept. 7	Sept. 8	Distinct.	Con.,brown.	0.10	10.45	1.75	8.70	.0114	.0280 .0236	.16	.0120	.0012
3126	Sept. 7	Sept. 8	Distinct.	Con.,brown.	0.05	10.95	1.85	9.10	.0054	.0312 .0206	.23	.0280	.0011
Av.	....	....	....	....	0.07	11.02	1.81	9.21	.0148	.0324 .0230	.24	.0177	.0015

Odor, mouldy. —— The samples were collected from the river at the South Street bridge as follows: No. 3112, at 9.45 A.M.; No. 3117, at 11.45 A.M.; No. 3121, at 3.10 P.M.; No. 3126, at 5.25 P.M.

Chemical Examination of Water from the Housatonic River, below the Confluence of the East and West Branches.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Exam-ination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albu-minoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
3114	Sept. 7	Sept. 8	Slight.	Sli't, brown.	0.20	11.60	2.05	9.55	.0120	.0234 .0202	.17	.0050	.0010
3119	Sept. 7	Sept. 8	Slight.	Sli't, brown.	0.15	11.40	2.20	9.20	.0116	.0244 .0240	.21	.0150	.0010
3127	Sept. 7	Sept. 8	Slight.	Con., dark.	0.10	10.75	1.60	9.15	.0134	.0270 .0206	.18	.0180	.0009
3128	Sept. 7	Sept. 8	Distinct.	Con., dark.	0.10	10.75	2.05	8.70	.0124	.0284 .0196	.19	.0150	.0009
Av.	....	....	....	....	0.14	11.12	1.97	9.15	.0124	.0258 .0211	.19	.0132	.0010

Odor, very faint or none.——The samples were collected from the river at the first bridge below the confluence of the east and west branches, at several points in the width of the stream, as follows: No. 3114, at 10.20 A.M.; No. 3119, at 12.30 P.M.; No. 3127, at 4.45 P.M.; No. 3128, at 5.15 P.M.

Chemical Examination of Water from the Housatonic River at Lenox.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Exam-ination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albu-minoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
3168	Sept. 13	Sept. 14	Slight.	Very slight.	0.15	11.65	2.00	9.65	.0076	.0322 .0274	.21	.0350	–
3185	Sept. 14	Sept. 18	Very slight.	Sl't, earthy and floc't.	0.10	10.95	1.40	9.55	.0102	.0188 .0162	.20	.0120	.0015
3186	Sept. 14	Sept. 18	Very slight.	Very slight.	0.10	11.20	1.70	9.50	.0084	.0184 .0158	.21	.0180	.0013
3187	Sept. 17	Sept. 18	Very slight.	Sli't, earthy.	0.15	11.90	1.65	10.25	.0090	.0188 .0160	.22	.0180	.0017
3188	Sept. 17	Sept. 18	Very slight.	Sl't, earthy and floc't.	0.15	12.20	1.65	10.55	.0134	.0160 .0150	.22	.0180	.0019
Av.	....	....	....	....	0.13	11.58	1.68	9.90	.0097	.0208 .0181	.21	.0202	.0016

Odor, distinctly vegetable.——The samples were collected from the river at the dam of the Smith Paper Company, near Lenox Station. Sample No. 3168 was collected at 3 P.M., when the surface of the river was 15 inches below the crest of the dam. No. 3185 was collected at 8.30 A.M., and No. 3186 at 3 P.M., while the water was 18 inches below the crest of the dam. No. 3187 was collected at 9 A.M., and No. 3188 at 3 P.M., while the water was two feet below the crest of the dam.

Microscopical Examination.

	1888.				
	3168.	3185.	3186.	3187.	3188.
1. Blue-green Algæ, ...	pr.	0.0	0.0	0.0	0.0
2. Other Algæ, ...	6.3	1.5	0.4	1.1	0.5
3. Fungi, ...	11.0	0.1	0.0	0.0	0.0
4. Animal Forms, ...	0.4	pr.	0.2	0.0	pr.

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ, *Chlorococcus;* Zoosporeæ, *Scenedesmus;* Desmidiaceæ; Diatomaceæ, *Synedra.* 3. Schizomycetes, *Crenothrix.* 4. Protozoa, *Dinobryon;* Rotifera; Entomostraca.

Chemical Examination of Water from the Housatonic River at Great Barrington.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
277	July 7	July 8	Slight.	Con., heavy.	0.10	12.95	1.75	11.20	.0075	.0161	.24	.0030	–
514	Aug. 9	Aug. 10	None.	Slight.	0.50	12.10	1.80	10.30	.0051	.0161	.17	.0130	–
699	Sept. 6	Sept. 7	Slight.	Very slight.	0.15	13.03	0.67	12.36	.0024	.0079	.17	.0260	–
891	Oct. 5	Oct. 6	Very slight.	Sli't, e'rthy.	0.30	13.10	0.95	12.15	.0013	.0145	.22	.0130	–
1104	Nov. 3	Nov. 4	Slight.	Con., e'rthy.	0.15	13.30	1.65	11.65	.0000	.0116	.26	.0150	–
1325	Dec. 5	Dec. 6	Distinct.	Slight.	0.10	12.00	1.70	10.30	.0029	.0090	.21	.0200	–
	1888.												
1534	Jan. 4	Jan. 5	Distinct.	Con., e'rthy.	0.30	8.85	1.55	7.30	.0023	.0143	.10	.0150	.0002
1891	Feb. 25	Feb. 27	Slight.	Consid'ble.	0.10	9.45	1.60	7.85	.0002	.0153	.12	.0350	.0002
1949	Mar. 5	Mar. 6	Distinct.	Slight.	0.20	12.00	1.70	10.30	.0036	.0146	.24	.0300	.0003
2152	Apr. 3	Apr. 4	Distinct.	Much, earthy.	0.05	9.50	1.10	8.40	.0012	.0176	.12	.0200	.0001
2353	May 3	May 4	Slight.	Consid'ble, brown.	0.20	7.05	1.10	5.95	.0000	.0132 .0090	.09	.0100	.0002
2561	June 6	June 7	Slight.	Con., e'rthy.	0.10	11.20	1.75	9.45	.0028	.0132 .0122	.15	.0070	.0002
2704	July 2	July 3	Very slight.	Slight.	0.10	11.95	1.60	10.35	.0050	.0150 .0120	.23	.0180	.0009
2887	Aug. 6	Aug. 7	Slight.	Slight.	0.00	12.55	1.80	10.75	.0060	.0146 .0134	.26	.0120	.0005
3147	Sept. 10	Sept. 11	Slight.	Slight.	0.10	13.50	1.90	11.60	.0038	.0144 .0122	.25	.0100	.0005
3310	Oct. 3	Oct. 4	Distinct.	Slight.	0.10	12.15	1.50	10.65	.0004	.0150 .0138	.14	.0100	.0003
3496	Nov. 6	Nov. 7	Distinct.	Slight.	0.10	11.05	1.75	9.30	.0000	.0140 .0112	.16	.0150	.0003
3659	Dec. 5	Dec. 6	Distinct.	Sli't, e'rthy.	0.05	10.60	1.30	9.30	.0012	.0114 .0086	.16	.0300	.0002

Chemical Examination of Water from the Housatonic River at Great Barrington — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
3828	Jan. 7	Jan. 8	Slight, milky.	Sli't, white.	0.10	11.15	0.90	10.25	.0004	.0098 .0074	15	.0250	.0002
3984	Feb. 6	Feb. 8	Distinct, milky.	Con., white.	0.00	11.60	1.25	10.35	.0016	.0170 .0110	.18	.0220	.0002
4276	Mar. 11	Mar. 12	Distinct.	Sli't, e'rthy, and floc't.	0.20	10.85	1.50	9.35	.0006	.0110 .0086	.16	.0200	.0004
4467	Apr. 3	Apr. 5	Distinct.	Consid'ble.	0.10	8.90	1.00	7.90	.0020	.0156 .0102	.14	.0150	.0007
4619	May 6	May 7	Veryslight.	Consid'ble.	0.15	9.90	1.70	8.20	.0006	.0132 .0116	.13	.0090	.0003
Av.	....	......	....	....	0.14	11.21	1.42	9.79	.0022	.0137	.18	.0171	.0003

Hardness in July, 1887, 8.8; in May, 1888, 5.3. Odor, faintly vegetable, frequently mouldy.—— The samples were collected from the river at the Leavitt Street bridge below the village.

Microscopical Examination.

	1888. June.	1888. July.	1888. Aug.	1888. Sept.	1888. Oct.	1888. Nov.	1888. Dec.	1889. Jan.	1889. Feb.	1889. Mar.	1889. Apr.	1889. May.
1. Blue-green Algæ, ...	0.1	pr.	0.2	0.0	0.0	pr.	0.0	–	0.0	0.0	pr.	0.0
2. Other Algæ, ...	3.1	1.9	3.8	3.5	0.2	1.1	0.5	–	0.2	1.2	0.5	68.2
3. Fungi, ...	0.0	pr.	pr.	0.0	0.0	0.0	0.0	–	0.0	0.0	0.0	0.0
4. Animal Forms, ...	0.2	pr.	pr.	0.0	0.0	0.1	0.0	–	pr.	0.4	0.7	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ, *Scenedesmus;* Desmidiaceæ; Diatomaceæ, *Asterionella, Fragillaria, Melosira, Synedra.* 3. Schizomycetes. 4. Protozoa.

Ipswich River.

The Ipswich River is formed by the confluence of several small brooks in Wilmington, Mass., and flows thence in a generally northeasterly direction to tide water at Ipswich, draining at this point an area of 148.2 square miles. The drainage area is generally a gently rolling country with numerous small hills, the summit of the highest of which is about 400 feet above mean sea level; it contains a very large amount of meadow and swampy land, especially in the vicinity of the streams.

The fall of the stream is slight and its current sluggish. There are very few ponds or storage reservoirs in the basin, and the dry-weather flow of the river is small. The amount of manufacturing on the stream is small, the most important factories being located at Ipswich just above tide water.

The following table gives statistics of the drainage area and population above three points on the river in the town of Ipswich : —

LOCALITY.	Distance above Tide Water. Miles.	Drainage Area. Sq. Miles.	Population (1885).	Population per Square Mile.
Ipswich River, just above the mouth of Miles River, .	2	128.6	6,798	53
Ipswich River, just below the mouth of Miles River, .	2	145.6	8,267	57
Ipswich River, at last dam (tide water), ...	0	148.2	11,603	78

The population is very much scattered, a large proportion of the inhabitants being engaged in agriculture. Ipswich, located at the mouth of the river, is the largest town, and contained in 1885 a population of 4,207. The population on the watershed has increased but very slightly since 1865, and, if Ipswich is excluded, has shown a slight decrease. None of the towns in the valley are provided with a public water supply except Middleton, which obtains a supply from the Danvers works, but sources within the valley are used by cities and towns outside. The city of Salem and town of Beverly draw their supply of water from Wenham Lake, located at the head of Miles River, while the town of Danvers obtains a supply from Middleton Pond in Middleton. The city of Malden has the right to take the waters of Martin's Pond in North Reading as a source of water supply. None of the towns in the valley have a system of sewerage.

This river is one of the larger streams in the eastern portion of the State, and has received consideration as a possible future source of water supply for the northerly suburbs of Boston. It is comparatively free from artificial pollution, but is dark colored, and contains much vegetable matter in solution, owing to the large area of swampy land on the watershed.

Samples of water for examination have been taken from the river, in the vicinity of North Reading, on one occasion only. The results are given below. Examinations of other surface waters in

the Ipswich basin have been made, and are given in the preceding portion of this report, as follows: —

Danvers, Middleton Pond, ... page 112
Lynnfield, Suntaug Lake, ... page 211
North Reading, Martin's Pond, ... page 259
Salem, Wenham Lake, ... page 286

Chemical Examination of Water from the Ipswich River above North Reading.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
4186	Mar. 1	Mar. 2	Very slight.	None.	1.1	4.35	1.90	2.45	.0000	.0216 .0204	.52	.0050	.0002
4187	Mar. 1	Mar. 2	Very slight.	Very slight.	1.0	3.65	1.60	2.05	.0000	.0174 .0152	.31	.0070	.0004
4188	Mar. 1	Mar. 2	Very slight.	Very slight.	1.0	4.55	2.05	2.50	.0000	.0212 .0192	.42	.0080	.0002

Hardness of No. 4187, 1.3; of No. 4188, 1.2.——Sample No. 4186 was collected from the Ipswich River at Eames' saw mill, 1 mile above the mouth of Martin's Brook. No. 4187 was collected from Martin's Brook at Park Street, one-fourth of a mile above the Ipswich River. No. 4188 was collected from the Ipswich River at the railroad bridge, about one-fourth of a mile below the mouth of Martin's Brook.

Microscopical Examination.

	1889. No. 4186.	1889. No. 4187.	1889. No. 4188.
1. Blue-green Algæ,	0.0	0.0	0.0
2. Other Algæ,	0.0	1.3	0.3
3. Fungi,	0.0	0.0	0.0
4. Animal Forms,	pr.	0.7	pr.

Groups and principal genera of organisms observed: 2. Palmellaceæ; Diatomaceæ. 4. Protozoa.

Merrimack River.

The Merrimack River is, with the exception of the Connecticut, the largest in the State. It is formed in the central part of New Hampshire, by the confluence of the Pemigewasset and Winni-

piscogee rivers, and thence flows in a direction a little east of south nearly to Lowell, Mass., where it turns to the east, and runs in a north-easterly direction to the sea at Newburyport. The total length of the river, including the Pemigewasset, which is a part of the main stream, is about 168 miles, of which 119 are in New Hampshire and 49 in Massachusetts. It is affected by the tides up to a point between Haverhill and Lawrence, 21 miles from its mouth.

The river at its mouth drains an area of 4,965 square miles. The physical characteristics of this area vary greatly in its different parts. The river has its source in the Franconia Mountains, and the whole upper portion of the drainage area is mountainous; further down it is hilly. In the lower portions there are large areas of flat land, and much low, wet land, particularly in the valleys of the Concord and Shawsheen rivers.

There are three very large water powers on the river, — at Manchester, N. H., and Lowell and Lawrence, Mass. These powers are thoroughly developed and utilized, mainly by cotton and woolen mills. The mills are of such magnitude that they not only utilize the vast water power of the river, but use, in addition, a large amount of steam power, particularly at Lowell. All of these establishments, and very many others on the tributaries of the river, discharge their manufacturing wastes into the streams.

The cities and towns on the river and its tributaries having a population of more than 10,000 each are given in the following table: —

CITY OR TOWN.	Population.
Concord, N. H. (1880),	13,843
Manchester, N. H. (1880),	32,630
Fitchburg, Mass. (1885),	15,375
Nashua, N. H. (1880),	13,397
Lowell, Mass. (1885),	64,107
Marlborough, Mass. (1885),	10,941
Lawrence, Mass. (1885),	38,862
Haverhill, Mass. (1885),	21,795
Newburyport, Mass. (1885),	13,716
Total,	224,666

All of these cities and towns, and many smaller towns on the area drained by the river, have public water supplies, and very nearly all of the places above named have systems of sewerage discharging directly into the streams. The drainage areas and populations at different points on the river are given in the following table : —

LOCALITY.	Distance from Mouth. Miles.	Area. Sq. Miles.	Population (1885).	Population per Sq. Mile.
Pemigewasset at mouth,	110	1,013*	–	–
Outlet of Lake Winnipiseogee at dam at Lake Village,	124	366	10,400	28
Winnipiseogee River at mouth,	110	480*	–	–
Just above mouth of Nashua River,	53	3,448	160,653	47
Above dam at Lowell,	39	4,097	230,266	56
Above dam at Lawrence,	27	4,634	362,803	78
Above Haverhill,	18	4,819	423,577	88
At mouth,	0	4,965	450,794†	91

* Taken from the Census of 1880; Volume XVI., Water Power.
† Taken from the Census of 1880; Volume, Population, p. liv.

Of the total population on the drainage area above Haverhill in 1885, 173,680 were in New Hampshire and 249,897 in Massachusetts.

The summer flow of this stream is quite large, both on account of the large area of the watershed, and the storage furnished by Lake Winnipiseogee and other lakes in the lake region of New Hampshire, and by the many storage reservoirs and mill ponds on the branches of the river.

The character of the water of the river would naturally vary much between its source and its mouth, independently of any pollution from artificial sources, on account of the varying character of the water brought into it from its different tributaries.

Analyses of the water of the river at Nashua, Lowell, Lawrence, and Haverhill, and of Lake Winnipiseogee at its outlet, are given in detail on pp. 447–461 ; and a table showing the flow of the Merrimack River at Lawrence is given on p. 462. Analyses of water of the Nashua, Concord and Shawsheen rivers are given under these heads in this portion of the report. The water of the Pemigewasset River has not been analyzed ; but, as it comes from a mountainous district, and drains one-fourth of the total area above Lowell, it

undoubtedly has a favorable effect upon the character of the river water at the latter place. The water supplied from Lake Winnipiseogee is of excellent quality; and the quantity in summer is much larger in proportion to the drainage area than that supplied by other tributaries. The Nashua and Concord rivers discharge into the Merrimack River water which is inferior in quality to that of the main stream, and have respectively about one-eighth and one-tenth as much drainage area as the main river at Lowell.

Lake Winnipiseogee is fed mainly by small streams flowing from the hills and mountains about it. It has an area of 71$\frac{3}{4}$ square miles, and its shape is very irregular. Several long bays or arms extend from it, and it contains a great many large and small islands, so that it has a very extended shore line. Its level is controlled by the dam at Lake Village, and it can be drawn down four feet below the top of the dam.

The sample at Nashua is taken from the Merrimack just above the mouth of the Nashua River, and, consequently, does not contain any of the sewage or manufacturing wastes from this city. The river has, however, above this point, received the sewage of Manchester and Concord, N. H., situated respectively 16 and 34 miles up the river. The next sampling point is a short distance above the dam at Lowell, 14 miles below Nashua, and directly opposite the inlet of the Lowell Water Works. Samples were taken at this place from the river, and were also taken from the inlet chamber of the Lowell Water Works, where the water comes directly in from the river. Other samples were taken at Central Bridge, Lowell, below where the river receives a part of the sewage of the city, and much manufacturing waste from the mills on its banks. There is no opportunity to collect a fair sample immediately below the city, on account of the rapids known as Hunt's Falls, where the river descends about 11 feet. The next sampling place was therefore located four-fifths of a mile above the dam of the Essex Company at Lawrence, and directly opposite the intake of the Lawrence Water Works. This point is 9 miles below Lowell, which is a sufficient distance to permit the sewage discharged into the river at the latter place, on the southerly side of the stream, to be thoroughly mixed with the water in all parts of the stream. The remaining places at which samples were taken regularly are below Lawrence, one and three-eighths miles below the dam, and above Haverhill. The former point is so near Lawrence that it may be

doubted if the sewage of the city thoroughly mingles with the river water before reaching it. The distance between the points is 7 miles. Samples were taken on one occasion just below Haverhill, but none farther down the river.

The character of the river water varies so much from time to time, from natural causes, and the dilution of the polluting matter turned into the stream is so great, that it is essential, in making comparisons between the analyses at different places, to use only those which correspond with each other as regards the time of collecting the samples.

The following table presents comparisons made upon this basis, with the further precaution that all portions of analyses affected by abnormal conditions are excluded, such as for instance freshets, when the water contains much silt.

Summary giving Comparison of Analyses of Samples collected at Corresponding Times from Different Points on the Merrimack River and at Lake Winnipiseogee.

Lake Winnipiseogee and above Nashua.

		Residue on Evaporation.			Ammonia.					Nitrogen as	
						Albuminoid.					
	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Total.	In Solution.	In Suspension.	Chlorine.	Nitrates.	Nitrites.
Number of determinations compared,	19	16	16	16	19	19	6	6	19	19	11
Mean of analyses, Lake Winnipi'ee,	0.00	2.13	0.59	1.54	.0003	.0091	.0085	.0015	.118	.0038	.0000
Mean of analyses, above Nashua, .	0.34	3.73	1.09	2.64	.0014	.0153	.0132	.0032	.148	.0074	.0002
Increase, ...	0.34	1.60	0.50	1.10	.0011	.0062	.0047	.0017	.030	.0036	.0002

Above Nashua and above Lowell.

Number of determinations compared,	18	15	15	15	18	18	6	6	18	18	10
Mean of analyses above Nashua, .	0.34	3.78	1.11	2.67	.0015	.0153	.0135	.0028	.149	.0073	.0002
Mean of analyses above Lowell, .	0.34	3.83	1.03	2.80	.0021	.0154	.0136	.0026	.164	.0099	.0002
Increase, ...	0.00	0.05	0.08*	0.13	.0006	.0001	.0001	.0002*	.015	.0026	.0000

* Decrease.

Above Lowell and at Central Bridge, Lowell.

		Residue on Evaporation.			Ammonia.					Nitrogen as	
						Albuminoid.					
	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Total.	In Solution.	In Suspension.	Chlorine.	Nitrates.	Nitrites.
Number of determinations compared,	23	23	23	23	23	23	11	11	23	23	16
Mean of analyses above Lowell, .	0.31	3.62	1.01	2.61	.0018	.0149	.0124	.0022	.154	.0092	.0002
Mean of anal's at Cent'l B'ge, Lowell,	0.32	3.82	1.08	2.74	.0014	.0170	.0130	.0041	.163	.0079	.0002
Increase, ...	0.01	0.20	0.07	0.13	.0004*	.0021	.0006	.0019	.009	.0013*	.0000

Above Lowell and above Lawrence.

Number of determinations compared,	30	20	20	20	31	31	21	21	28	29	25
Mean of analyses above Lowell, .	0.31	3.54	0.96	2.58	.0018	.0148	.0125	.0024	.152	.0091	.0002
Mean of analyses above Lawrence, .	0.32	3.77	1.05	2.72	.0025	.0175	.0142	.0033	.178	.0088	.0002
Increase, ...	0.01	0.23	0.09	0.14	.0007	.0027	.0017	.0009	.026	.0003*	.0000

Above Lawrence and below Lawrence.

Number of determinations compared,	20	20	20	20	21	21	11	11	19	19	15
Mean of analyses above Lawrence, .	0.32	3.77	1.05	2.72	.0021	.0174	.0137	.0035	.155	.0090	.0003
Mean of analyses below Lawrence, .	0.34	4.09	1.18	2.91	.0010	.0195	.0149	.0040	.199	.0086	.0003
Increase, ...	0.02	0.32	0.13	0.19	.0011*	.0021	.0012	.0005	.044	.0004*	.0000

Below Lawrence and above Haverhill.

Number of determinations compared,	20	20	20	20	21	21	10	10	19	19	15
Mean of analyses below Lawrence, .	0.34	4.09	1.18	2.91	.0010	.0195	.0148	.0042	.199	.0086	.0003
Mean of analyses above Haverhill, .	0.32	4.15	1.19	2.96	.0025	.0197	.0154	.0043	.204	.0097	.0003
Increase, ...	0.02*	0.06	0.01	0.05	.0015	.0002	.0006	.0001	.005	.0011	.0000

* Decrease.

To further facilitate comparison, the following table has been compiled from that given above. The analyses above Lowell and above Lawrence have been transferred from that table to the one below, and are taken as standards because they represent the greatest

number of determinations. The analyses at other places have been calculated from these by adding or subtracting the differences from place to place.

Summary of Analyses of Merrimack River Water at Various Points, compiled from the Previous Table.

	Color.	Residue on Evaporation.			Ammonia.				Chlorine.	Nitrogen as	
						Albuminoid.					
		Total.	Loss on Ignition.	Fixed.	Free.	Total.	In Solution.	In Suspension.		Nitrates.	Nitrites.
Lake Winnipiseogee, N. H., . .	0.00	1.89	0.54	1.35	.0001	.0085	.0077	.0009	.107	.0029	.0000
Above Nashua, N. H., . . .	0.31	3.49	1.04	2.45	.0012	.0147	.0124	.0026	.137	.0065	.0002
Above Lowell, ...	0.31	3.54	0.96	2.58	.0018	.0148	.0125	.0024	.152	.0091	.0002
Above Central Bridge, Lowell, .	0.32	3.74	1.03	2.71	.0014	.0169	.0131	.0043	.161	.0078	.0002
Above Lawrence, ...	0.32	3.77	1.05	2.72	.0025	.0175	.0142	.0033	.178	.0088	.0002
Below Lawrence, ...	0.34	4.09	1.18	2.91	.0014	.0196	.0154	.0038	.222	.0084	.0002
Above Haverhill, ...	0.32	4.15	1.19	2.96	.0029	.0198	.0160	.0039	.227	.0095	.0002

NOTE.—This table and the preceding include analyses of later date than those given in the detailed tables which follow.

The average rate of flow per 24 hours at Lawrence during the days represented by the largest number of determinations was 9,145 cubic feet per second, which is about four times the low water flow of the river in an ordinary dry season.

The quantities shown in the table increase from place to place, in most cases with a fair degree of regularity. Exceptions to this rule occur in the columns of free ammonia and of the albuminoid ammonia in suspension. In both of these there is on the whole as in the other cases, an increase in the quantities, though between certain places there is a noticeable decrease. In the case of the free ammonia, there is an increase from Nashua to above Lowell, from Central Bridge to above Lawrence, and from below Lawrence to above Haverhill. These sections of the river have, as a rule, but little fall to agitate the water, excepting a short distance below Central Bridge, where the water descends about 11 feet over rapids known as Hunt's Falls. In the first two sections the river receives considerable pollution from the sewage of Nashua and other places in the Nashua basin, and from the city of Lowell, but in the last section the increase in free ammonia takes place, without any large amount of polluting matter entering the river to account for it. From above Lowell to Central Bridge, and from above to below

Lawrence, there is a decrease in the amount of free ammonia, notwithstanding the large amount of ammonia which enters the river in the sewage from these cities. Whether this is in any way connected with the large fall of the river at these places cannot be said with certainty.

In the case of the albuminoid ammonia in suspension the results are just the reverse of those found with the free ammonia. The amount of the former is greater just below where polluting matters are discharged into the stream, where the current is strong, and less at more distant points, where the current is sluggish, so that the suspended particles are deposited.

Chemical Examination of Water from Lake Winnipiseogee at Lake Village, N. H.

[Parts per 100,000.]

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.
	1887.												
87	June 11	June 14	Slight.	Slight.	0.00	2.35	1.00	1.35	.0002	.0076	.14	.0000	–
304	July 11	July 12	None.	None.	0.00	2.10	0.80	1.30	.0002	.0085	.14	.0000	–
548	Aug. 15	Aug. 16	Very slight.	Very slight.	0.00	2.22	0.52	1.70	.0005	.0077	.13	.0000	–
738	Sept. 12	Sept. 13	Slight.	Very slight.	0.00	2.22	0.60	1.62	.0000	.0088	.14	.0070	–
964	Oct. 17	Oct. 18	Very slight.	Slight.	0.00	2.10	0.45	1.65	.0000	.0098	.10	.0000	–
1187	Nov. 14	Nov. 15	Very slight.	Slight.	0.00	2.05	0.65	1.40	.0000	.0080	.11	.0030	–
1383	Dec. 12	Dec. 13	Very slight.	Sli't, white.	0.00	1.80	0.30	1.50	.0000	.0107	.14	.0020	–
	1888.												
1604	Jan. 16	Jan. 17	Very slight.	Very slight.	0.00	1.95	0.45	1.50	.0001	.0079	.12	.0030	.0000
1814	Feb. 13	Feb. 14	Very slight.	None.	0.00	2.35	0.75	1.60	.0009	.0113	.14	.0080	.0001
2001	Mar. 12	Mar. 14	Very slight.	Very slight.	0.00	2.05	0.55	1.50	.0023	.0092	.11	.0070	.0002
2230	Apr. 16	Apr. 17	Very slight.	Very slight.	0.00	2.10	0.50	1.60	.0000	.0086	.13	.0050	.0000
2427	May 14	May 15	Very slight.	Very slight.	0.00	2.20	0.50	1.70	.0000	.0058	.10	.0000	.0000
2585	June 11	June 12	Very slight.	Sli't, white.	0.00	2.33	0.53	1.80	.0000	.0090	.12	.0080	.0000
2825	July 23	July 24	Slight.	None.	0.00	2.10	0.30	1.80	.0000	.0096 .0062	.10	.0020	.0000
2922	Aug. 13	Aug 14	Very slight.	Very slight.	0.00	2.30	0.50	1.80	.0006	.0098 .0080	.13	.0050	.0000
3198	Sept. 17	Sept. 18	Very slight.	Very slight.	0.00	2.15	0.65	1.50	.0000	.0096 .0078	.12	.0060	.0000
3369	Oct. 15	Oct. 16	Very slight.	Very slight.	0.05	2.00	0.60	1.40	.0000	.0100 .0036	.08	.0060	.0000
3532	Nov. 12	Nov. 13	Slight.	Sli't, white.	0.00	1.90	0.60	1.30	.0000	.0106 .0100	.09	.0060	.0000
3688	Dec. 10	Dec. 11	Very slight.	Sli't, white.	0.00	1.95	0.50	1.45	.0000	.0104 .0076	.10	.0050	.0000

Chemical Examination of Water from Lake Winnipiseogee at Lake Village, N.H. — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
3847	Jan. 14	Jan. 15	Very slight.	Very slight.	0.05	2.00	0.60	1.40	.0000	.0068 .0054	.10	.0060	.0000
4030	Feb. 18	Feb. 19	Very slight.	Very slight.	0.00	1.95	0.40	1.55	.0000	.0072 .0064	.10	.0030	.0000
4333	Mar. 18	Mar. 19	Very slight.	Very slight.	0.03	2.00	0.60	1.40	.0008	.0124 .0112	.12	.0040	.0000
4517	Apr. 15	Apr. 16	Slight.	Slight.	0.00	1.95	0.55	1.40	.0000	.0106 .0092	.11	.0030	.0000
4658	May 13	May 14	Very slight.	Very slight.	0.03	2.00	0.65	1.35	.0000	.0118 .0100	.12	.0030	.0000
Av.	....	....	....	....	0.01	2.12	0.59	1.53	.0002	.0092	.12	.0038	.0000

Hardness in May, 1888, 1.3. Odor, none, rarely vegetable.——The samples were collected at the Lake Company's dam at Lake Village, N. H.

Microscopical Examination.

	1888. May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	1889. Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ, . .	0.0	0.0	0.0	pr.	pr.	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, . . .	0.0	1.6	0.7	0.9	1.3	1.1	0.0	1.4	0.4	0.4	1.4	16.9	0.2
3. Fungi, ...	0.0	0.0	0.0	0.0	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, . . .	0.0	0.7	0.0	pr.	pr.	0.2	0.0	pr.	0.0	pr.	0.1	65.6	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Melosira*. 3. Schizomycetes. 4. Protozoa, *Dinobryon;* Spongiaria; Entomostraca.

Chemical Examination of Water from the Merrimack River at Nashua, N. H.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
90	June 14	June 15	None.	Con., brown.	0.50	4.37	1.95	2.42	.0006	.0128	.21	.0070	-
320	July 12	July 13	Slight.	Sli't, brown.	0.40	4.50	1.30	3.20	.0002	.0143	.12	.0040	-
561	Aug. 15	Aug. 17	Very slight.	Sli't, brown.	0.60	3.92	1.07	2.85	.0031	.0158	.12	.0070	-
767	Sept. 14	Sept. 15	Distinct.	Sli't, earthy.	0.15	3.75	0.85	2.90	.0011	.0169	.18	.0030	-

Chemical Examination of Water from the Merrimack River at Nashua, N. H. — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
980	Oct. 18	Oct. 19	Slight.	Sli't, earthy and floc't.	0.30	3.85	0.70	3.15	.0022	.0180	.18	.0070	–
1198	Nov. 15	Nov. 16	Distinct.	Con., earthy and floc't.	0.35	4.25	1.20	3.05	.0018	.0196	.20	.0050	–
1424	Dec. 15	Dec. 16	Decided.	Much, e'rthy and floc't.	0.45	8.90 **3.30**	1.70 **1.25**	7.20 **2.05**	.0012	.0188	.12	.0100	–
	1888.												
1642	Jan. 18	Jan. 20	Distinct.	Slight.	0.20	3.70	1.05	2.65	.0010	.0109	.10	.0200	–
1851	Feb. 15	Feb. 17	Distinct.	Very slight.	0.30	3.55	1.00	2.55	.0014	.0135	.17	.0100	.0000
2037	Mar. 15	Mar. 19	Distinct.	Consid'ble.	0.20	3.70	0.95	2.75	.0013	.0122	.17	.0100	.0001
2262	Apr. 18	Apr 20	Distinct.	Con., e'rthy.	0.30	4.80	0.60	4.20	.0000	.0111	.11	.0080	.0002
2455	May 16	May 18	Decided.	Much, earthy.	0.25	10.85 **3.15**	1.40 **1.45**	9.45 **1.70**	.0000	.0144 **.0136**	.10	.0050	.0001
2616	June 14	June 16	Very slight.	Sli't, earthy and floc't.	0.40	**3.20**	**1.05**	**2.15**	.0026	.0128 **.0120**	.11	.0060	.0001
2805	July 19	July 20	Slight.	Sli't, brown.	0.20	**3.10**	**0.90**	**2.20**	.0004	.0184 **.0132**	.11	.0020	.0002
2954	Aug. 15	Aug. 17	Slight.	Sli't, earthy.	0.20	**3.30**	**0.80**	**2.50**	.0028	.0128 **.0106**	.16	.0050	.0002
3227	Sept. 20	Sept. 21	Slight.	Sli't, earthy.	0.30	**3.90**	**1.35**	**2.55**	.0034	.0208 **.0160**	.18	.0050	.0005
3395	Oct. 17	Oct. 19	Very slight.	Sli't, earthy and floc't.	0.60	**4.25**	**1.30**	**2.95**	.0008	.0152 **.0146**	.15	.0070	.0003
3555	Nov. 14	Nov. 16	Slight.	Sli't, earthy.	0.50	**3.40**	**1.15**	**2.25**	.0022	.0176 **.0144**	.14	.0100	.0002
3705	Dec. 11	Dec. 13	Decided.	Con., e'rthy.	0.20	**2.95**	**0.90**	**2.05**	.0008	.0140 **.0106**	.14	.0090	.0002
Av.	....	....	....	....	0.34	5.01	1.15	3.86	.0014	.0153	.15	.0074	.0002

Hardness in May, 1888, 0.6. Odor, very faintly vegetable, frequently none. —— The samples were collected from the middle of the Merrimack River, above the Nashua, opposite the mouth of the old canal. There were heavy rains just previous to the collection of No. 1198 and No. 3227.

Microscopical Examination.

	1888. June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1. Blue-green Algæ, ...	0.0	pr.	0.0	pr.	0.0	0.0	0.0
2. Other Algæ, ...	3.2	1.6	2.9	2.0	1.3	pr.	0.7
3. Fungi, ...	4.0	1.0	0.0	pr.	1.0	0.0	0.0
4. Animal Forms, ...	pr.	0.1	0.6	pr.	0.2	0.0	0.1

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Melosira*, *Synedra*, *Tabellaria*. 3. Schizomycetes, *Crenothrix*. Protozoa; Nematoda; Rotifera.

Chemical Examination of Water from the Merrimack River above Lowell opposite the Inlet to the Lowell Water Works.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1887.												
103	June 14	June 15	Slight.	Very slight.	0.40	3.90	1.55	2.35	.0020	.0122	.16	.0130	–
332	July 14	July 15	Very slight.	Slight.	0.40	3.55	1.15	2.40	.0010	.0133	.12	.0030	–
576	Aug. 18	Aug. 19	Very slight.	Very slight.	0.60	4.07	1.15	2.92	.0027	.0177	.14	.0070	–
782	Sept. 15	Sept. 16	Slight.	Slight.	0.15	3.95	0.80	3.15	.0018	.0148	.20	.0070	–
998	Oct. 20	Oct. 21	Very slight.	Very slight.	0.40	3.85	0.70	3.15	.0042	.0152	.19	.0080	–
1209	Nov. 17	Nov. 18	Decided.	Con., earthy and floc't.	0.75	5.15	1.25	3.90	.0026	.0203	.24	.0090	–
1415	Dec. 15	Dec. 16	Decided.	Considerable, earthy.	0.40	5.60	1.50	4.10	.0007	.0169	.15	.0120	–
	1888.												
1644	Jan. 19	Jan. 21	Very slight.	Very slight.	0.30	3.95	1.00	2.95	.0016	.0116	.13	.0200	.0001
1848	Feb. 16	Feb. 17	Slight.	Very slight.	0.35	3.90	0.95	2.95	.0046	.0150	.19	.0180	.0000
2020	Mar. 15	Mar. 16	Slight.	Very slight.	0.20	3.65	0.90	2.75	.0031	.0122	.21	.0080	.0002
2263	Apr. 19	Apr. 20	Distinct.	Con., earthy and floc't.	0.25	6.30 **2.65**	0.70 **0.65**	5.60 **2.00**	.0000	.0116	.16	.0100	.0003
2450	May 17	May 18	Decided.	Much, earthy.	0.25	13.15 **2.70**	1.10 **1.10**	12.05 **1.60**	.0000	.0154 **.0110**	.09	.0030	.0001
2603	June 14	June 15	Very slight.	Sli't, earthy and floc't.	0.35	**3.55**	**0.95**	**2.60**	.0020	.0162 **.0128**	.16	.0100	.0003
2809	July 19	July 23	Very slight.	Very slight.	0.10	**3.20**	**0.55**	**2.65**	.0014	.0142 **.0124**	.19	.0050	.0001
2958	Aug. 16	Aug. 17	Slight.	Slight.	0.20	**3.95**	**0.85**	**3.10**	.0026	.0140 **.0124**	.22	.0070	.0002
2959	Aug. 16	Aug. 17	Slight.	Slight.	0.25	**3.75**	**0.90**	**2.85**	.0022	.0158 **.0144**	.22	.0080	.0003
2960	Aug. 16	Aug. 17	Slight.	Slight.	0.15	**3.90**	**0.65**	**3.25**	.0018	.0180 **.0150**	.22	.0070	.0002
3228	Sept. 20	Sept. 21	Slight.	Slight, earthy.	0.20	**3.60**	**1.05**	**2.55**	.0026	.0186 **.0172**	.16	.0080	0005
3229	Sept. 20	Sept. 21	Slight.	Slight, earthy.	0.30	**3.55**	**1.35**	**2.20**	.0028	.0174 **.0158**	.15	.0030	.0004
3397	Oct. 18	Oct. 19	Slight.	Slight.	0.50	**3.35**	**1.25**	**2.10**	.0004	.0164 **.0134**	.11	.0070	.0002
3396	Oct. 18	Oct. 19	Slight.	Slight.	0.50	**3.50**	**1.25**	**2.25**	.0000	.0176 **.0148**	.13	.0060	.0003
3556	Nov. 15	Nov. 16	Slight.	Slight, earthy.	0.50	**3.20**	**1.30**	**1.90**	.0002	.0152 **.0122**	.10	.0150	.0002
	1889.												
3874	Jan. 17	Jan. 19	Slight, milky.	Considerable, earthy.	0.15	**2.75**	**0.50**	**2.25**	.0000	.0100 **.0100**	.12	.0050	.0004
4084	Feb. 21	Feb. 23	Slight.	Slight.	0.20	**3.20**	**1.00**	**2.20**	.0008	.0108 **.0090**	.16	.0180	.0004
4368	Mar. 21	Mar. 22	Distinct, milky.	Considerable, earthy.	0.20	**2.85**	**1.00**	**1.85**	.0000	.0150 **.0114**	.09	.0030	.0003

Chemical Examination of Water from the Merrimack River above Lowell opposite the Inlet to the Lowell Water Works — Concluded.

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.
	1889.												
4536	Apr. 18	Apr. 19	Slight.	Considerable, earthy.	0.20	2.70	0.75	1.95	.0002	.0130 .0112	.08	.0020	.0002
4690	May 18	May 20	Slight.	Con., earthy and floc't.	0.20	3.25	0.95	2.30	.0032	.0156 .0138	.15	.0050	.0002
Av.	....	....	....	....	0.32	5.09	1.06	4.03	.0016	.0147	.15	.0087	.0002

NOTE. — In making the above average the mean analysis has been used where more than one is given for any day.

Hardness in May, 1888, 0.6. Odor, very faintly vegetable, often none, occasionally mouldy. —— The samples were collected from the river opposite the inlet to the Lowell Water Works one foot beneath the surface. Nos. 2958 and 2959 were collected from all parts of the width of the river, No. 2958 being collected from the north half of the river and No. 2959 being collected from the south half. No. 3228 was from the middle of the north half of the river and No. 3229 from the middle of the south half. No. 3397 was from the north half of the river and No. 3396 from the south half.

Microscopical Examination.

	1888.											1889.				
	June.	July.	Aug.	Aug.	Aug.	Sept.	Sept.	Oct.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ,	pr.	0.0	pr.	0.0	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	pr.
2. Other Algæ, .	4.2	0.9	2.4	5.7	4.3	1.8	2.6	pr.	0.5	1.7	0.2	0.3	0.2	0.5	0.9	0.3
3. Fungi, . . .	0.1	0.1	0.0	0.0	pr.	pr.	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, .	0.0	0.1	pr.	0.2	0.2	pr.	0.1	0.0	0.0	0.0	pr.	0.0	pr.	pr.	0.0	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ, *Chlorococcus;* Zoosporeæ, *Scenedesmus;* Desmidiaceæ; Diatomaceæ, *Synedra, Tabellaria.* 3. Schizomycetes. 4. Protozoa; Rotifera.

Chemical Examination of Water from the Merrimack River above Lowell at the Inlet to the Lowell Water Works.

[Parts per 100,000.]

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.
	1887.												
104	June 14	June 15	Decided.	Consid'ble, brown.	0.30	4.20	1.50	2.70	.0019	.0119	.24	.0130	–
333	July 14	July 15	Very slight.	Very slight.	0.40	3.90	1.35	2.55	.0025	.0151	.14	.0070	–

Chemical Examination of Water from the Merrimack River above Lowell at the Inlet to the Lowell Water Works— Concluded.

Number.	Date of Collection.	Date of Exam-ination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albu-minoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
577	Aug. 18	Aug. 19	Decided.	Slight, reddish brown.	0.50	5.62	0.85	4.77	.0129	.0131	.19	.0260	–
783	Sept. 15	Sept. 16	Slight.	Slight.	0.15	4.10	1.00	3.10	.0030	.0160	.21	.0070	–
1000	Oct. 20	Oct. 21	Very slight.	Very slight.	0.25	4.10	0.85	3.25	.0035	.0136	.21	.0080	–
1211	Nov. 17	Nov. 18	Decided.	Con., earthy and floc't.	0.75	5.35	1.05	4.30	.0026	.0246	.26	.0100	–
1417	Dec. 15	Dec. 16	Decided.	Con., earthy and floc't.	0.40	5.60	1.30	4.30	.0016	.0167	.18	.0100	–
	1888.												
1645	Jan. 19	Jan. 21	Slight.	Slight.	0.25	3.80	0.85	2.95	.0012	.0120	.14	.0200	.0001
1849	Feb. 16	Feb. 17	Slight.	Very slight.	0.35	3.70	0.75	2.95	.0056	.0157	.18	.0150	.0000
2022	Mar. 15	Mar. 16	Distinct.	Very slight.	0.20	3.65	0.85	2.80	.0034	.0106	.17	.0100	.0001
2265	Apr. 19	Apr. 20	Decided.	Much, brown.	0.35	7.15 2.90	0.80 0.80	6.35 2.10	.0022	.0126	.14	.0200	.0002
2451	May 17	May 18	Decided.	Much, earthy.	0.30	12.15 2.85	1.30 1.65	10.85 1.20	.0004	.0188 .0110	.11	.0080	.0000
2604	June 14	June 15	Slight.	Sli't, earthy and floc't.	0.30	3.70	0.80	2.90	.0056	.0142 .0124	.11	.0150	.0001
2810	July 19	July 21	Slight.	Sli't, earthy and floc't.	0.10	3.40	0.70	2.70	.0024	.0170 .0116	.18	.0050	.0002
Av.	....	....	....	....	0.33	5.28	1.04	4.24	.0035	.0151	.18	.0124	.0001

Hardness in May, 1888, 0.6. Odor, very faintly vegetable, often none, occasionally mouldy. —— The samples were collected in the inlet chamber where water comes in directly from the river and before it mingles with water from the filter-gallery or filter-inlet.

Microscopical Examination.

	1888. May.	1888. June.	1888. July.
1. Blue-green Algæ,	0.0	0.0	0.0
2. Other Algæ,	pr.	2.5	7.9
3. Fungi,	0.0	pr.	2.0
4. Animal Forms,	0.0	0.1	0.1

Groups and principal genera of organisms observed: 2. Palmellaceæ, *Chlorococcus;* Zoosporeæ, *Tetraspora;* Desmidiaceæ; Diatomaceæ, *Synedra*, *Tabellaria*. 3. Schizomycetes, *Crenothrix*. 4. Protozoa; Rotifera; Entomostraca.

Chemical Examination of Water from the Merrimack River at Central Bridge, Lowell.
[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1887.												
102	June 14	June 15	Slight.	Slight.	0.30	4.40	1.82	2.58	.0016	.0147	.20	.0130	–
331	July 14	July 15	Slight.	Slight.	0.40	4.25	1.25	3.00	.0002	.0170	.16	.0030	–
575	Aug. 18	Aug. 19	Distinct.	Con., earthy and floc't.	0.60	4.75	1.35	3.40	.0007	.0212	.16	.0070	–
781	Sept. 15	Sept. 16	Decided.	Con., earthy and floc't.	0.20	4.45	1.05	3.40	.0022	.0182	.22	.0070	–
999	Oct. 20	Oct. 21	Very slight.	Sli't. earthy and floc't.	0.30	4.10	0.65	3.45	.0031	.0172	.22	.0100	–
1210	Nov. 17	Nov. 18	Decided.	Con., earthy and floc't.	0.75	5.85	1.50	4.35	.0012	.0209	.26	.0090	–
1416	Dec. 15	Dec. 16	Decided.	Con., earthy and floc't.	0.45	5.60	1.30	4.30	.0006	.0180	.19	.0110	–
	1888.												
1660	Jan. 21	Jan. 23	Slight.	Very slight.	0.20	4.05	1.05	3.00	.0017	.0137	.11	.0100	.0001
1845	Feb. 16	Feb. 17	Slight.	Very slight.	0.35	4.35	1.00	3.35	.0058	.0183	.20	.0150	.0001
2021	Mar. 15	Mar. 16	Distinct.	Slight.	0.30	4.00	1.05	2.95	.0019	.0151	.18	.0100	.0001
2264	Apr. 19	Apr. 20	Distinct.	Much, brown.	0.25	7.05 **2.50**	0.70 **0.90**	6.35 **1.60**	.0002	.0139	.13	.0080	.0003
2449	May 17	May 18	Decided.	Much, earthy.	0.25	11.95 **2.90**	1.40 **0.90**	10.55 **2.00**	.0000	.0154 **.0112**	.10	.0020	.0001
2602	June 14	June 15	Decided.	M'ch, e'rthy and floc't.	0.30	**3.45**	**1.15**	**2.30**	.0016	.0172 **.0142**	.13	.0090	.0003
2813	July 19	July 23	Slight.	Sli't, earthy and floc't.	0.10	**3.75**	**0.90**	**2.85**	.0042	.0178 **.0148**	.19	.0050	.0001
2966	Aug. 17	Aug. 18	Slight.	Slight.	0.25	**3.75**	**0.90**	**2.85**	.0014	.0178 **.0134**	.22	.0090	.0001
3230	Sept. 20	Sept. 21	Slight.	Consid'ble, earthy.	0.25	**3.65**	**1.25**	**2.40**	.0030	.0202 **.0142**	.17	.0050	.0006
3400	Oct. 18	Oct. 19	Slight.	Slight.	0.70	**3.45**	**1.00**	**2.45**	.0004	.0168 **.0134**	.14	.0070	.0003
3557	Nov. 15	Nov. 16	Slight.	Con., earthy and fibrous.	0.50	**3.35**	**1.15**	**2.20**	.0004	.0184 **.0126**	.10	.0070	.0003
3784	Dec. 21	Dec. 22	Decided.	Consid'ble.	0.30	**2.70**	**1.10**	**1.60**	.0000	.0206 **.0134**	.08	.0070	.0002
	1889.												
3870	Jan. 17	Jan. 19	Sli't, milky.	Consid'ble, earthy.	0.15	**3.15**	**1.10**	**2.05**	.0000	.0174 **.0110**	.15	.0050	.0003
4085	Feb. 21	Feb. 23	Slight.	Consid'ble.	0.20	**3.35**	**0.90**	**2.45**	.0000	.0138 **.0114**	.15	.0150	.0002
4369	Mar. 21	Mar. 22	Distinct, milky.	Con., earthy and floc't.	0.20	**2.95**	**0.75**	**2.20**	.0002	.0150 **.0110**	.12	.0030	.0003
4537	Apr. 18	Apr 19	Slight.	Consid'ble, earthy.	0.20	**2.70**	**0.85**	**1.85**	.0000	.0154 **.0110**	.09	.0060	.0002
4691	May 18	May 20	Distinct.	Consid'ble.	0.25	**3.15**	**0.95**	**2.20**	.0026	.0176 **.0158**	.15	.0050	.0002
Av.	....	....	....	....	0.32	5.40	1.18	4.22	.0014	.0171	.16	.0078	.0002

Hardness in May, 1888, 0.5. Odor, very faintly vegetable or mouldy, frequently none.——The samples were collected from Central Bridge on the down stream side at the southern pier five feet beneath the surface, with the exception of No. 1660, which was collected 30 feet north of the south pier, and No. 1845, which was collected 90 feet north of the south pier.

Microscopical Examination.

	1888.							1889.					
	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ,	0.0	0.2	pr.	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ,	6.2	4.6	3.5	4.3	0.4	0.2	1.1	0.5	0.5	2.3	0.8	0.6
3. Fungi,	3.0	5.0	pr.	pr.	pr.	0.0	0.0	0.0	pr.	0.0	0.0	0.0
4. Animal Forms,	pr.	0.1	0.1	pr.	0.0	0.0	pr.	0.0	0.0	0.1	1.0	pr.

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ, *Chlorococcus;* Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Synedra.* 3. Schizomycetes, *Crenothrix.* 4. Protozoa, *Dinobryon;* Spongiaria.

Chemical Examination of Water from the Merrimack River below Lowell.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
2955	Aug. 16	Aug. 17	Slight.	Con.,earthy and floc't.	0.25	4.30	0.95	3.35	.0002	.0190 .0148	.31	.0070	.0003
2956	Aug. 16	Aug. 17	Slight.	Con.,earthy and floc't.	0.20	5.30	1.45	3.85	.0000	.0174 .0136	.26	.0070	.0003
2957	Aug. 16	Aug. 17	Slight.	Con.,earthy and floc't.	0.20	4.10	0.85	3.25	.0010	.0178 .0122	.24	.0080	.0003
Av.	....	....	....	....	0.22	4.57	1.08	3.49	.0004	.0181 .0135	.27	.0073	.0003

Odor, very faint or none.——The samples were collected from the river, one foot beneath the surface, at the foot of the last rapids at Hunt's Falls, from a boat which was being rowed across the river. No. 2955 was collected from the south third of river; No. 2956 from the middle third, and No. 2957 from the north third.

Microscopical Examination.

	1888.		
	2955.	2956.	2957.
1. Blue-green Algæ,	0.0	pr.	0.1
2. Other Algæ,	3.6	5.4	6.9
3. Fungi,	0.0	0.0	pr.
4. Animal Forms,	0.2	pr.	1.2

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ, *Chlorococcus;* Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Synedra.* 3. Schizomycetes. 4. Protozoa, *Dinobryon;* Nematoda.

Chemical Examination of Water from the Merrimack River at the Intake of the Lawrence Water Works, collected One Foot beneath the Surface.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Exam-ination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albu-minoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
108	June 15	June 16	Slight, milky.	Consid'ble, brown.	0.40	4.02	1.75	2.27	.0009	.0207	.17	.0130	–
345	July 15	July 16	Distinct.	Slight.	0.40	4.40	1.00	3.40	.0027	.0170	.19	.0070	–
582	Aug. 19	Aug. 20	Decided.	Consid'ble, earthy.	0.55	6.25	1.42	4.83	.0059	.0275	.21	.0130	–
798	Sept. 16	Sept. 17	Slight.	Slight.	0.30	4.65	1.00	3.65	.0017	.0192	.24	.0070	–
1009	Oct. 21	Oct. 22	Slight.	Sl't, earthy and floc't.	0.50	4.95	1.05	3.90	.0034	.0187	.28	.0080	–
1220	Nov. 18	Nov. 19	Distinct.	Con., e'rthy and floc't.	0.65	4.65	1.20	3.45	.0018	.0234	.24	.0100	–
	1888.												
1648	Jan. 20	Jan. 21	Slight.	Slight, earthy.	0.30	4.30	1.15	3.15	.0022	.0140	.17	.0180	.0001
1859	Feb. 17	Feb. 18	Distinct.	Slight.	0.30	4.15	1.05	3.10	.0051	.0204	.25	.0120	.0001
2026	Mar. 16	Mar. 17	Distinct.	Very slight.	0.20	3.85	1.00	2.85	.0030	.0179	.19	.0100	.0001
2274	Apr. 20	Apr. 21	Distinct.	Con., earthy and fibr'us.	0.25	6.05 2.60	0.65 0.80	5.40 1.80	.0004	.0130	.11	.0090	.0003
2495	May 22	May 24	Decided.	Much, earthy.	–	–	–	–	.0000	.0146	–	–	–
2619	June 15	June 16	Distinct.	Considera-ble.	0.30	3.60	0.90	2.70	.0028	.0196 .0116	.20	.0080	.0002
2814	July 20	July 23	Slight.	Very slight.	0.15	3.65	0.85	2.80	.0064	.0198 .0156	.18	.0050	.0002
2973	Aug. 17	Aug. 18	Slight.	Slight, earthy.	0.25	3.80	0.90	2.90	.0046	.0190 .0156	.25	.0100	.0002
2975	Aug. 17	Aug. 18	Slight.	Slight, earthy.	0.25	3.85	0.90	2.95	.0036	.0190 .0146	.24	.0100	.0002
2974	Aug. 17	Aug. 18	Slight.	Slight, earthy.	0.25	3.90	0.80	3.10	.0048	.0226 .0154	.23	.0120	.0002
3242	Sept. 21	Sept. 22	Very slight.	Consid'ble, earthy.	0.15	3.80	1.35	2.45	.0040	.0222 .0180	.17	.0100	.0003
3406	Oct. 19	Oct. 20	Distinct.	Consid'ble, earthy.	0.70	3.90	1.60	2.30	.0000	.0164 .0148	.14	.0050	.0003
3407	Oct. 19	Oct. 20	Slight.	Slight, earthy.	0.60	3.65	1.45	2.20	.0002	.0186 .0164	.15	.0070	.0002
3565	Nov. 16	Nov. 17	Decided.	Considera-ble.	0.45	3.20	1.30	1.90	.0000	.0192 .0158	.14	.0050	.0005
	1889.												
3876	Jan. 18	Jan. 19	Distinct.	Con., earthy and floc't.	0.15	2.95	0.90	2.05	.0006	.0138 .0098	.13	.0060	.0003
4089	Feb. 22	Feb. 23	Slight.	Slight.	0.20	3.35	1.05	2.30	.0006	.0126 .0102	.17	.0180	.0004
4380	Mar. 22	Mar. 23	Slight.	Con., light gray.	0.25	3.10	0.75	2.35	.0006	.0124 .0100	.11	.0040	.0006

Chemical Examination of Water from the Merrimack River at the Intake of the Lawrence Water Works, collected One Foot beneath the Surface — Con.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
4543	Apr. 19	Apr. 20	Slight.	Con., earthy and floc't.	0.25	2.70	0.75	1.95	.0008	.0152 .0122	.12	.0050	.0003
4687	May 17	May 18	Distinct.	Con., earthy and floc't.	0.30	3.35	0.90	2.45	.0030	.0164 .0146	.18	.0060	.0004
Av.	....	....	....	....	0.33	4.73	1.13	3.60	.0023	.0180	.18	.0091	.0003

Note. — In making the above average, the mean analysis has been used where more than one analysis is given for any day.

Hardness in May, 1888, 1.1. Odor, very faintly vegetable, often none, occasionally mouldy. —— The samples were collected from the river over the end of the intake pipe of the Lawrence Water Works, one foot beneath the surface, until August, 1888. After that time they were generally collected from the middle of the river opposite the intake. No. 2973 was collected about one foot beneath the surface, half way between the north bank and the middle of the river. No. 2975 was collected from the middle of the river. No. 2974 was collected midway between the middle of the river and the south bank. No. 3242 was collected from the middle of the south half of the river. Nos. 3403 and 3407 were from the north and south halves of the river respectively. For volumes of water flowing in the river at times when samples were collected for analysis, see page 462.

Microscopical Examination.

	1888.									1889.				
	June.	July.	Aug.	Aug.	Aug.	Sept.	Oct.	Oct.	Nov.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ,	pr.	0.0	0.0	pr.	pr.	0.0	0.0	0.0	0.0	0.0	0.0	pr.	0.0	0.0
2. Other Algæ,	5.4	4.5	4.8	3.2	5.0	0.8	0.1	0.2	pr.	0.9	0.3	1.3	1.7	0.5
3. Fungi,	2.0	3.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	pr.	0.0	0.0
4. Animal Forms,	0.1	pr.	0.2	0.4	pr.	pr.	0.0	0.0	0.0	0.0	0.0	0.2	pr.	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ, *Chlorococcus*; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Synedra*, *Tabellaria*. 3. Schizomycetes, *Crenothrix*, *Leptothrix*. 4. Protozoa; Rotifera.

Chemical Examination of Water from the Merrimack River at the Intake of the Lawrence Water Works, collected Six Feet or more beneath the Surface.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.		Nitrates.	Nitrites.
	1887.												
107	June 15	June 16	Slight, milky.	Consid'ble, brown.	0.40	4.80	1.77	3.03	.0004	.0170	.17	.0060	–
347	July 15	July 16	Slight.	Consid'ble, brown.	0.40	4.80	1.00	3.80	.0025	.0177	.15	.0070	–
583	Aug. 19	Aug. 20	Decided.	Consid'ble, earthy.	0.55	6.55	1.37	5.18	.0034	.0258	.21	.0130	–
799	Sept. 16	Sept. 17	Slight.	Slight.	0.30	4.75	0.90	3.85	.0012	.0194	.27	.0260	–
1010	Oct. 21	Oct. 22	Very slight.	Sli't, earthy and floc't.	0.50	4.65	0.65	4.00	.0038	.0210	.27	.0100	–
1221	Nov. 18	Nov. 19	Decided.	Con., e'rthy and floc't.	0.65	4.85	1.25	3.60	.0018	.0217	.23	.0100	–
	1888.												
1649	Jan. 20	Jan. 21	Slight.	Very slight.	0.25	4.05	1.05	3.00	.0018	.0142	.16	.0180	.0001
1860	Feb. 17	Feb. 18	Slight.	Very slight.	0.30	4.15	1.10	3.05	.0042	.0184	.22	.0150	.0001
2027	Mar. 16	Mar. 17	Distinct.	Very slight.	0.25	3.90	1.05	2.85	.0029	.0174	.20	.0150	.0002
2275	Apr. 20	Apr. 21	Distinct.	Much, eart'y and fibr'us.	0.25	7.15 **2.55**	0.80 **0.85**	6.35 **1.70**	.0003	.0134	.10	.0100	.0003
2494	May 22	May 24	Decided.	Much, eart'y and fibr'us.	–	–	–	–	.0004	.0150	–	–	–
2620	June 15	June 16	Distinct.	Consid'ble.	0.50	**3.50**	**1.10**	**2.40**	.0036	.0180 **.0154**	.20	.0080	.0002
2815	July 20	July 23	Slight.	Sli't, earthy and floc't.	0.15	**3.65**	**0.70**	**2.95**	.0078	.0204 **.0150**	.21	.0050	.0002
Av.	....	....	....	....	0.38	4.96	1.09	3.87	.0026	.0184	.20	.0119	.0002

Hardness in May, 1888, 1.1. — Odor, very faintly vegetable, occasionally mouldy. —— The samples were collected from the river six feet beneath the surface, with the exception of Nos. 2494 and 2620, which were collected eight feet beneath the surface, and No. 2275, which was collected ten feet beneath the surface. For volumes of water flowing in the river at times when samples were collected for analysis, see page 462.

Microscopical Examination.

	1888.				
	March.	April.	May.	June.	July.
1. Blue-green Algæ, ...	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	pr.	pr.	pr.	1.2	9.3
3. Fungi, ...	0.0	0.0	0.0	1.0	1.0
4. Animal Forms, ...	0.0	0.0	0.0	0.0	0.1

Groups and principal genera of organisms observed: 2. Palmellaceæ, *Chlorococcus*; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Synedra*. 3. Schizomycetes, *Crenothrix*, *Leptothrix*. 4. Protozoa.

Chemical Examination of Water from the Merrimack River below Lawrence and just above the Mouth of the Shawsheen River.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.		Nitrates.	Nitrites.
	1887.												
111	June 15	June 16	Sli't, milky.	Consid'ble.	0.50	5.85	2.17	3.68	.0003	.0182	–	.0000	–
343	July 15	July 16	Distinct.	Consid'ble.	0.50	5.05	1.57	3.48	.0004	.0194	.17	.0070	–
581	Aug. 19	Aug. 20	Decided.	Con., e'rthy.	0.55	6.37	1.15	5.22	.0033	.0288	.20	.0130	–
797	Sept. 16	Sept. 17	Decided.	Slight.	0.25	4.90	1.15	3.75	.0002	.0214	.25	.0070	–
1008	Oct. 21	Oct. 22	Slight.	Consid'ble.	0.50	5.90	1.15	4.75	.0000	.0242	.29	.0050	–
1224	Nov. 18	Nov. 19	Slight.	Slight.	0.45	5.10	1.35	3.75	.0022	.0250	.24	.0100	–
1427	Dec. 16	Dec. 17	Decided.	Con., earthy and floc't.	0.45	5.65	1.50	4.15	.0014	.0183	.20	.0130	–
	1888.												
1652	Jan. 20	Jan. 21	Distinct.	Slight.	0.30	4.30	1.10	3.20	.0024	.0156	.17	.0120	.0004
1863	Feb. 17	Feb. 18	Distinct.	Very slight.	0.30	4.70	1.30	3.40	.0055	.0211	.26	.0120	.0001
2030	Mar. 16	Mar. 17	Decided.	Slight.	0.30	4.35	1.30	3.05	.0034	.0194	.23	.0100	.0002
2273	Apr. 20	Apr. 21	Decided.	Consid'ble.	0.30	7.60 **2.70**	0.75 **0.75**	6.85 **1.95**	.0000	.0190	.12	.0120	.0004
2466	May 18	May 19	Distinct.	Consid'ble.	0.35	11.25 **2.95**	1.30 **1.10**	9.95 **1.85**	.0000	.0188 **.0158**	.11	.0080	.0000
2621	June 15	June 16	Slight.	Slight.	0.50	**3.60**	**0.80**	**2.80**	.0000	.0176 **.0158**	.22	.0080	.0003
2818	July 20	July 23	Distinct.	Consid'ble.	0.15	**3.75**	**0.90**	**2.85**	.0028	.0224 **.0180**	.23	.0050	.0002
2969	Aug. 17	Aug. 18	Slight.	Consid'ble.	0.30	**4.20**	**0.90**	**3.30**	.0000	.0260 **.0168**	.28	.0030	.0002
2970	Aug. 17	Aug. 18	Slight.	Slight.	0.30	**3.95**	**0.95**	**3.00**	.0000	.0212 **.0152**	.25	.0100	.0002
2971	Aug. 17	Aug. 18	Slight.	Slight.	0.25	**4.20**	**1.00**	**3.20**	.0014	.0200 **.0158**	.23	.0080	.0002
3245	Sept. 21	Sept. 22	Very slight.	Con., earthy and floc't.	0.15	**4.05**	**1.40**	**2.65**	.0004	.0226 **.0168**	.18	.0120	.0004
3405	Oct. 19	Oct. 20	Distinct.	Consid'ble.	0.70	**3.95**	**1.55**	**2.40**	.0000	.0166 **.0160**	.16	.0080	.0003
3568	Nov. 16	Nov. 17	Distinct.	Consid'ble.	0.50	**3.25**	**1.10**	**2.15**	.0000	.0184 **.0162**	.16	.0070	.0005
3722	Dec. 14	Dec. 15	Distinct.	Slight.	0.15	**3.50**	**1.35**	**2.15**	.0018	.0146 **.0120**	.18	.0080	.0003
	1889.												
3880	Jan. 18	Jan. 19	Decided.	Consid'ble.	0.15	**3.05**	**1.05**	**2.00**	.0002	.0144 **.0118**	.15	.0070	.0002
4093	Feb. 22	Feb. 23	Slight.	Consid'ble.	0.20	**3.45**	**0.80**	**2.65**	.0004	.0154 **.0124**	.20	.0180	.0004
4383	Mar. 22	Mar. 23	Slight.	Consid'ble.	0.25	**3.25**	**0.80**	**2.45**	.0018	.0160 **.0124**	.15	.0050	.0004

Chemical Examination of Water from the Merrimack River below Lawrence and just above the Mouth of the Shawsheen River — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
4546	Apr. 19	Apr. 20	Slight.	Con., earthy and floc't.	0.25	2.80	1.00	1.80	.0000	.0172 .0124	.16	.0050	.0004
4689	May 17	May 18	Slight.	Consid'ble.	0.30	3.70	1.20	2.50	.0004	.0240 .0158	.20	.0060	.0005
Av.	....	....	....	....	0.35	5.92	1.32	4.60	.0011	.0196	.19	.0085	.0003

Note.—In making the above average, the mean analysis has been used where more than one analysis is given for any day.

Hardness in May, 1888, 0.9. Odor, very faintly vegetable or mouldy, frequently none.——The samples were collected from the river, generally at a point about one-third of the distance from the north to the south bank. No. 2969 was collected from the northerly third of the river, No. 2970 from the middle third, and No. 2971 from the southerly third. These samples were collected from a boat, the bottles being filled gradually as the boat was rowed across the river.

Microscopical Examination.

	1888. June.	July.	Aug.	Aug.	Aug.	Sept.	Oct.	Nov.	Dec.	1889. Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ, .	0.0	pr.	pr.	pr.	pr.	0.0	pr.	0.0	0.0	0.0	pr.	0.0	0.0	pr.
2. Other Algæ, . .	4.3	3.3	3.5	3.5	6.1	1.0	pr.	0.1	1.2	0.5	3.6	1.3	0.6	0.7
3. Fungi, ...	6.0	0.1	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, . .	pr.	0.1	0.1	0.6	0.3	0.2	0.0	0.0	0.1	0.0	0.1	pr.	0.0	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ, *Chlorococcus;* Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Melosira, Synedra, Tabellaria.* 3. Schizomycetes, *Leptothrix.* 4. Protozoa; Nematoda; Rotifera; Entomostraca.

Chemical Examination of Water from the Merrimack River above Haverhill.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
123	June 15	June 17	Decided.	Heavy, brown.	0.45	5.02	1.70	3.32	.0018	.0181	.15	.0060	–
338	July 15	July 15	Slight.	Consid'ble.	0.40	4.42	1.22	3.20	.0008	.0169	.13	.0070	–
586	Aug. 19	Aug. 20	Distinct.	Much, earthy.	0.50	6.70	1.05	5.65	.0037	.0281	.20	.0100	–

Chemical Examination of Water from the Merrimack River above Haverhill — Con.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
830	Sept. 20	Sept. 22	Very slight.	Slight.	0.35	4.65	0.95	3.70	.0073	.0213	.22	.0030	–
1013	Oct. 21	Oct. 22	Decided.	Con., earthy and floc't.	0.40	5.35	1.45	3.90	.0028	.0235	.30	.0170	–
1229	Nov. 18	Nov. 19	Slight.	Con., earthy and floc't.	0.50	5.30	1.55	3.75	.0024	.0240	.26	.0070	–
1425	Dec. 16	Dec. 16	Decided.	Consid'ble, earthy.	0.45	5.75	1.55	4.20	.0044	.0228	.22	.0120	–
	1888.												
1643	Jan. 20	Jan. 21	Slight.	Con., earthy and floc't.	0.30	5.15	1.85	3.30	.0038	.0244	.22	.0100	.0001
1858	Feb. 17	Feb. 18	Distinct.	Consid'ble.	0.25	4.55	1.10	3.45	.0047	.0205	.25	.0120	.0001
2031	Mar. 16	Mar. 17	Distinct.	Consid'ble.	0.25	4.85	1.15	3.70	.0034	.0219	.25	.0100	.0003
2268	Apr. 20	Apr. 20	Distinct.	Slight.	0.15	4.85 **2.75**	0.75 **0.75**	4.10 **2.00**	.0003	.0157	.15	.0120	.0002
2458	May 18	May 18	Decided.	Heavy, earthy.	0.35	9.35 **3.10**	1.55 **1.10**	7.80 **2.00**	.0000	.0146	.12	.0050	.0000
2607	June 15	June 15	Distinct.	Slight, earthy.	0.40	**3.65**	**1.15**	**2.50**	.0012	.0156	.17	.0100	.0002
2808	July 20	July 21	Distinct.	Consid'ble, brown.	0.20	**4.17**	**0.75**	**3.43**	.0010	.0236 **.0170**	.25	.0020	.0002
2978	Aug. 17	Aug. 18	Very slight.	Slight, earthy.	0.20	**4.50**	**0.95**	**3.55**	.0022	.0226 **.0148**	.26	.0090	.0002
2979	Aug. 17	Aug. 18	Slight.	Consid'ble, earthy.	0.25	**4.25**	**1.20**	**3.05**	.0022	.0206 **.0142**	.25	.0230	.0002
3246	Sept. 21	Sept. 22	Slight.	Consid'ble, earthy.	0.15	**4.00**	**1.45**	**2.55**	.0020	.0222 **.0172**	.19	.0180	.0004
3416	Oct. 22	Oct. 23	Distinct.	Sli't, earthy and floc't.	0.80	**3.90**	**1.35**	**2.55**	.0012	.0178 **.0156**	.16	.0060	.0003
3569	Nov. 16	Nov. 17	Decided.	Heavy.	0.50	**3.65**	**1.35**	**2.30**	.0000	.0194 **.0172**	.19	.0060	.0007
3792	Dec. 21	Dec. 24	Decided.	Much, e'rthy and floc't.	0.40	**3.00**	**1.20**	**1.80**	.0002	.0190 **.0152**	.11	.0080	.0004
	1889.												
3950	Jan. 31	Jan. 31	Distinct.	Consid'ble, black.	0.20	**3.40**	**0.90**	**2.50**	.0072	.0178 **.0142**	.21	.0090	.0003
4098	Feb. 22	Feb. 23	Distinct.	Consid'ble.	0.20	**4.15**	**1.05**	**3.10**	.0040	.0168 **.0126**	.23	.0200	.0004
4377	Mar. 22	Mar. 22	Distinct, milky.	Consid'ble, earthy.	0.20	**2.90**	**0.55**	**2.35**	.0018	.0162 **.0122**	.14	.0050	.0003
4541	Apr. 19	Apr. 20	Distinct.	Consid'ble.	0.25	**3.15**	**1.05**	**2.10**	.0022	.0200 **.0164**	.14	.0070	.0004
4685	May 17	May 18	Distinct.	Consid'ble.	0.30	**3.55**	**1.20**	**2.35**	.0024	.0218 **.0168**	.17	.0070	.0004
Av.	....	....	....	....	0.34	5.49	1.32	4.17	.0025	.0201	.19	.0094	.0003

Hardness in May, 1888, 0.6. Odor, very faintly vegetable or mouldy, frequently none. —— The samples were collected from the river about one mile above the Boston & Maine Railroad bridge at Haverhill.

Microscopical Examination.

	1888.								1889.				
	June.	July.	Aug.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ, . .	0.0	0.0	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, . . .	1.7	8.6	5.8	4.8	1.2	0.5	0.4	0.7	0.9	0.9	0.9	1.0	4.6
3. Fungi, ...	0.0	pr.	0.1	0.0	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, . . .	pr.	2.5	0.3	0.3	0.0	pr.	0.0	pr.	pr.	0.1	0.0	pr.	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ, *Chlorococcus;* Zoosporeæ, *Scenedesmus*, *Tetraspora;* Desmidiaceæ; Diatomaceæ, *Melosira*, *Synedra*, *Tabellaria.* 3. Schizomycetes. 4. Protozoa, *Dinobryon;* Rotifera; Entomostraca.

Chemical Examination of Water from the Merrimack River below Haverhill.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
2980	Aug. 17	Aug. 18	Slight.	Consid'ble, earthy.	0.2	4.25	1.30	2.95	.0030	.0212 .0170	.23	.0450	.0001
2981	Aug. 17	Aug. 18	Distinct.	Slight, earthy.	0.2	4.20	1.15	3.05	.0040	.0212 .0192	.24	.0400	.0002
Av.	....	....	....	....	0.2	4.22	1.22	3.00	.0035	.0212 .0181	.23	.0425	.0001

Odor, faintly mouldy.——The samples were collected from the river about one mile below the Haverhill foot bridge. Sample No. 2980 was taken from all parts of the north half of the river, about one foot beneath the surface. Sample No. 2981 was taken from the south half of the river in the same water.

Microscopical Examination.

No. 2980. 1. Blue-green algæ, 0.0; 2. Other algæ, 8.3; 3. Fungi, pr.; 4. Animal forms, 0.1. No. 2981. 1. Blue-green algæ, pr.; 2. Other algæ, 6.8; 3. Fungi, 0.0; 4. Animal forms, 0.3.

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ, *Chlorococcus;* Zoosporeæ, *Scenedesmus;* Desmidiaceæ; Diatomaceæ, *Synedra*, *Tabellaria.* 3. Schizomycetes. 4. Protozoa; Annelida.

Table showing the Flow of the Merrimack River at Lawrence.

MONTH.	Day on which Samples were collected at Lawrence.	Volume flowing in the River in Cubic Feet per Second.		
		Average Rate of Flow during 11 Hours of the Day on which Samples were collected.	Average Rate of Flow during 24 Hours of the Day on which Samples were collected.	Average Rate of Flow during 24 Hours for the Month.
1887.				
June,	15	5,600	4,700	9,248
July,	15	5,830	4,940	7,492
August,	19	12,240	9,830	9,556
September,	16	6,590	5,700	4,774
October,	21	4,050	2,650	3,474
November,	18	9,650	8,740	4,849
December,	15	11,490	10,720	7,070
1888.				
January,	20	13,050	12,110	9,820
February,	17	10,000	9,180	12,781
March,	16	7,740	6,950	14,676
April,	20	25,890	25,100	27,795
May,	22	16,050	15,420	23,650
June,	15	6,170	5,270	6,472
July,	20	3,500	2,450	2,442
August,	17	5,000	4,000	2,642
September,	21	10,920	9,970	7,840
October,	19	14,670	13,810	13,686
November,	16	15,520	14,510	15,034
December,	–	9,520	8,660	16,660
1889.				
January,	18	18,050	17,280	13,603
February,	22	8,470	7,630	7,198
March,	22	14,500	13,650	12,252
April,	19	11,740	10,870	12,363
May,	17	6,580	5,750	7,611

NOTE.—This table has been prepared from information furnished by Hiram F. Mills, engineer of the Essex Company, Lawrence, and member of the State Board of Health.

MILLER'S RIVER.

The Miller's River, one of the chief tributaries of the Connecticut, rises in the vicinity of Ashburnham, Mass., and flows in a generally westerly direction to the Connecticut River near Miller's Falls, about seven miles above the mouth of the Deerfield River and ten miles

south of the New Hampshire state line. The basin lies to the north of the Chicopee basin and occupies the northern portion of Worcester County and the eastern portion of Franklin County.

The drainage area of the river is, as a rule, hilly. Near its mouth the hills are very high and rise abruptly with steep slopes from the water. In other portions of the area the hills are more scattered, and in some places there are considerable areas of comparatively flat land. There are many lakes and ponds, the larger of which (16 in all) have an aggregate area of about 3,200 acres. Some of these bodies of water are used as storage reservoirs to supply the mills with water during dry seasons. The fall of the river is large, amounting to about 775 feet from Winchendon, which is near its head, to its mouth.

A careful examination of the Miller's River basin was made by the State Board of Health, Lunacy and Charity in 1880, the results of which are given in the supplementary report of the board for that year, pp. 12–21. The following table containing a summary of the polluting manufactures in the valley at that time is taken from page 20 of that report: —

MANUFACTURES.	Number.	Operatives Employed.
Cotton mills,	5	315
Woolen mills,	2	165
Shoddy mills,	8	310
Wool-scouring mills,	2	8
Paper mills,	2	25
Tanneries,	1	14
Machine shops and foundries,	14	618
Sewing machine factories,	1	400
Gas works,	1	2
Shoe factories,	2	240
Dye houses,	1	1
Blanket shops,	1	15
Totals,	40	2,113

This table does not include chair factories and other wood-working establishments, as they are not classed as polluting. These are, however, the chief manufacturing industries of the valley, and employ more operatives than all the others.

The population and drainage area above certain points on the main river and a tributary are given in the following table :

LOCALITY.	Distance from Mouth of River. Miles.	Drainage Area. Sq. Miles.	Population (1885).	Population per Square Mile.
Otter River below Gardner, at mouth of Pond Brook,	37.0	26.6	7,334	276
Dam of New Home Sewing Machine Co., Orange, .	13.5	324.3	-	-
Mouth of river, ...	0	393.2	27,174	69

The population per square mile is small, but is increasing quite rapidly, owing to the rapid growth of the larger towns. Most of the smaller towns are decreasing in population. Gardner (population in 1885, 7,283) is the largest town on the watershed, and nearly all of it drains naturally into Otter River, at or above the mouth of Pond Brook. The population is more dense above this point than above any other on the main river or its larger tributaries. The population of the valley is nearly all concentrated in the manufacturing towns and in the villages along the streams.

Three of the towns, Gardner, Athol and Orange, have public water supplies. Winchendon and Miller's Falls each have a limited supply from springs in the neighboring hills. The supply for Orange is usually obtained from a spring, but, as it does not furnish enough water in dry seasons, the supply is then taken directly from the river. At the present time no town in the valley has a system of sewerage, but sewers are soon to be built at Orange and Gardner.

Examinations of water collected from the river at its mouth have been made monthly from June, 1887, to May, 1889, inclusive. One sample collected from the river above Winchendon has also been examined. Measurements of the flow of the river at Orange were made during the months of October, November and December, 1887. Tables giving the results of these investigations are appended. Analyses of other surface waters in the basin may be found in the preceding portion of this report, as follows : —

Ashburnham, Upper Naukeag Pond, ... page 19
Athol, Buckman Brook Reservoir, ... page 20
Athol, Phillipston Reservoirs, ... page 21
Gardner, Crystal Lake, ... page 134

The water of the river is dark colored in all parts of its course, owing probably to contact with swamps. The analyses do not, however, indicate that the river is at present polluted to any considerable extent; a result which is due to the large volume of water flowing in the river in comparison with the population on the watershed, the absence of sewerage systems discharging directly into the streams, and the comparatively small quantity of polluting manufacturing wastes turned into them.

Chemical Examination of Water from Miller's River above Winchendon.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
2580	June 8	June 9	Very slight.	Consid'ble.	1.3	3.20	1.90	1.30	.0004	.0288 .0230	.06	.0060	.0000

Odor, faintly vegetable. —— The sample was collected from the river at the Pequot Mill dam, about two miles above Winchendon.

Microscopical Examination.

1. Blue-green algæ, 0.0; 2. Other algæ, 5.1; 3. Fungi, 0.0; 4. Animal forms, 0.2.

Groups and principal genera of organisms observed: 2. Palmellaceæ, *Chlorococcus;* Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Tabellaria, Asterionella.* 4. Protozoa; Entomostraca.

Chemical Examination of Water from Miller's River at Miller's Falls, Montague.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
72	June 9	June 11	–	–	1.00	4.27	1.75	2.52	.0038	.0294	.14	.0070	–
287	July 8	July 9	Very slight.	Slight.	0.90	4.35	2.00	2.35	.0020	.0277	.11	.0000	–
510	Aug. 9	Aug. 10	Slight.	Slight.	1.60	5.20	2.25	2.95	.0008	.0270	.11	.0070	–
704	Sept. 7	Sept. 8	Decided.	Slight.	0.90	4.25	1.42	2.83	.0019	.0214	.15	.0070	–
895	Oct. 6	Oct. 7	Slight.	Slight.	1.00	4.20	1.45	2.75	.0008	.0231	.15	.0130	–
1160	Nov. 11	Nov. 12	Slight.	Consid'ble, earthy.	0.70	5.25	1.75	3.50	.0005	.0228	.23	.0060	–
1328	Dec. 6	Dec. 7	Distinct.	Consid'ble, earthy.	0.90	4.60	1.70	2.90	.0000	.0212	.18	.0120	–

Chemical Examination of Water from Miller's River at Miller's Falls, Montague — Concluded.

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1888.												
1565	Jan. 9	Jan. 10	Very slight.	Consid'ble, brown.	1.10	4.75	1.75	3.00	.0000	.0165	.09	.0180	–
1852	Feb. 15	Feb. 17	Distinct.	Consid'ble, brown.	0.70	4.85	1.80	3.05	.0054	.0265	.16	.0090	.0000
2025	Mar. 12	Mar. 17	Decided.	Consid'ble, brown.	0.50	3.75	1.20	2.55	.0000	.0233	.14	.0060	.0002
2200	Apr. 11	Apr. 12	Distinct.	Consid'ble, brown.	0.50	3.40	1.15	2.25	.0000	.0165	.10	.0080	.0001
2394	May 9	May 10	Slight.	Consid'ble, brown.	0.75	3.45	1.40	2.05	.0004	.0176	.09	.0070	.0001
2625	June 18	June 19	Very slight.	Slight.	0.90	3.45	1.45	2.00	.0000	.0192 .0166	.08	.0020	.0000
2755	July 10	July 11	Very slight.	Slight.	0.70	3.40	1.40	2.00	.0012	.0182 –	.12	.0020	.0002
2948	Aug. 14	Aug. 16	Very slight.	Consid'ble, brown.	0.60	3.60	1.35	2.25	.0008	.0170 .0156	.12	.0060	.0001
3236	Sept. 20	Sept. 21	Slight.	Consid'ble, brown.	1.20	4.60	2.35	2.25	.0002	.0288 .0234	.13	.0080	.0007
3374	Oct. 16	Oct. 17	Very slight.	Slight.	1.10	4.05	1.70	2.35	.0010	.0238 .0220	.14	.0070	.0002
3573	Nov. 19	Nov. 20	Distinct.	Consid'ble, earthy.	1.30	3.65	1.85	1.80	.0000	.0194 .0176	.14	.0080	.0001
3791	Dec. 22	Dec. 24	Slight.	Con., earthy and floc't.	0.60	3.00	1.25	1.75	.0018	.0212 .0178	.10	.0070	.0003
	1889.												
3937	Jan. 26	Jan. 28	Very slight.	Sli't, earthy and floc't.	0.40	2.80	0.95	1.85	.0008	.0148 .0128	.08	.0120	.0002
4194	Mar. 2	Mar. 4	Slight.	Consid'ble, gray.	0.50	3.50	1.10	2.40	.0004	.0162 .0130	.14	.0090	.0003
4456	Apr. 1	Apr. 3	Very slight.	Consid'ble.	0.40	2.60	1.05	1.55	.0008	.0174 .0148	.07	.0070	.0001
4553	Apr. 22	Apr. 23	Very slight.	Consid'ble.	0.80	2.85	1.45	1.40	.0002	.0192 .0156	.10	.0030	.0001
4704	May 20	May 21	Slight.	Con., earthy and floc't.	1.00	3.40	1.50	1.90	.0010	.0220 .0180	.12	.0030	.0001
Av.	....	....	....	....	0.84	4.36	1.64	2.72	.0010	.0213	.12	.0073	.0002

Hardness in May, 1888, 0.8. Odor, very faintly vegetable, often none.—The samples were collected from Miller's River at the bridge near its mouth.

Microscopical Examination.

	1888.							1889.				
	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Mar.	Apr.	Apr.	May.
1. Blue-green Algæ,	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	pr.
2. Other Algæ,	1.1	10.8	1.0	2.5	0.3	0.8	1.1	0.2	0.2	1.1	0.5	5.1
3. Fungi,	1.0	0.3	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms,	pr.	0.0	0.0	pr.	0.0	0.3	pr.	pr.	0.0	0.0	0.1	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Synedra*. 3. Schizomycetes, *Crenothrix*. 4. Protozoa; Rotifera.

Table showing the Flow of Miller's River at Dam of New Home Sewing Machine Company, Orange.

MONTH.	Day on which Sample was collected for Analysis at Miller's Falls.	Flow during Working Hours on the Day the Sample was collected. Cu. ft. per Sec.	Average Flow during Working Hours for the Month. Cu. ft. per Sec.
1887.			
October,	6	396	358
November,	11	387	409
December,	6	440	469

NASHUA RIVER.

The Nashua River is formed at Lancaster, in the eastern part of Worcester County, by the confluence of its North and South branches, and flows north-easterly 22½ miles in Massachusetts and 9 miles in New Hampshire to the Merrimack River at Nashua. It drains a territory of 527.9 square miles, of which 444.4 are in Massachusetts and 83.5 in New Hampshire.

The North Branch is formed by the union of three streams in the south-western portion of the city of Fitchburg, and flows thence in a north-easterly direction to the central portion of the city, where it turns to the south-east and flows in this direction to its mouth.

The South Branch is formed at West Boylston by the union of the Stillwater and Quinepoxet rivers, which rise respectively in Princeton and Rutland, and thence flows south-easterly and then north-easterly 12½ miles to its mouth. About three miles above its mouth it passes through Clinton, which is the only large town upon it.

The main river has no important town upon it in Massachusetts.

The drainage area of the river is generally hilly and rolling, the hills near the sources of the larger tributaries being high and steep. In the immediate vicinity of the main river the land is generally level and elevated but slightly above the stream. In most parts, however, the land is high enough to confine the river within its banks except during high freshets. The North and South branches and their tributaries have a rapid fall, and are well utilized for power. The main river has but little fall, except near its mouth at Nashua, where there are large cotton mills. There are a number of ponds and storage reservoirs on the drainage area, by which the dry weather flow of the streams is increased to some extent. The available storage on the North and South branches of the river is greater than in other parts of the watershed.

The following table gives statistics of drainage areas, population, etc., in the Nashua River Valley : —

LOCALITY.	Distance above Mouth of Nashua River.	Drainage Area.	Population (1885).	Population per Square Mile.
	Miles.	Sq. Miles.		
North Branch, at Wallace's Paper Mill, W. Fitchburg,	47.5	57.8	4,510	78
North Branch, at Duck Mill, below Fitchburg, . .	43.0	63.8	15,980	250
North Branch, at North Leominster, ...	41.0	83.1	18,277	220
Monoosnoc Brook, at mouth, ...	40.0	11.7	2,943	251
North Branch, at mouth, ...	31.5	130.9	24,873	190
South Branch, at Cunningham's bridge, above Clinton,	37.5	114.4	7,726	67
South Branch, at Lancaster Mills, Clinton, . . .	35.5	117.6	8,512	72
South Branch, above Coachlace Brook, Clinton, .	33.0	119.3	10,980	92
Coachlace Brook, at mouth, Clinton, ...	33.0	5.9	5,393	914
South Branch, at mouth, ...	31.5	130.4	17,030	131
Total North and South branches, ...	31.5	261.3	41,903	160
Nashua River, at Mine Falls, above Nashua, . .	4.0	521.6	57,162	110
Nashua River, at mouth, ...	0.0	527.9	67,409	128

The portions of the valley which possess the greatest interest from a sanitary point of view are the north branch where it is affected by the sewage of Fitchburg and Leominster, the lower portion of the south branch below Clinton, and the upper portion of this stream, which may be considered as a possible future source of water

supply for the large population in and about Boston. These portions have received special attention with regard to the analyses of the waters, and will be described in some detail.

The city of Fitchburg had in 1885 a population of 15,375, and the town of Leominster, five miles below Fitchburg, a population of 5,297, making the aggregate population in these two towns which drain into the north branch 20,672. The population of these towns in 1888 is estimated at 25,500. The city of Fitchburg has many sewers which discharge directly into the river. The town of Leominster discharges some sewage into Monoosnoc Brook, a tributary of the north branch. This brook has a fall of over 130 feet, which is fully utilized for power, and it consequently receives much manufacturing sewage.

The fall of the river in the towns of Fitchburg and Leominster is about 300 feet, nearly all of which is utilized for power by mills of various kinds from which the manufacturing wastes and sewage of the operatives are turned directly into the stream. Below Leominster down to the junction of the branches the stream has much less fall and receives comparatively little polluting matter.

The town of Clinton had in 1885 a population of 8,945 and in 1888 an estimated population of 9,700. The larger portion of this town drains naturally into a small tributary of the south branch, known as Coachlace Brook, upon which is also located the extensive works of the Bigelow Carpet Company. A smaller portion of the town drains directly into the south branch in the vicinity of the Lancaster Cotton Mills. During the time in which the analyses given in this report were being made, the sewage from a large part of the population in the valley of Coachlace Brook, and the wool washings and other manufacturing wastes from the works of the Bigelow Carpet Company were turned either directly into the brook or into a mill pond upon it known as Counterpane Pond, making them very offensive. An intercepting sewer has since been built to divert the sewage from the brook and carry it to the river.

The Lancaster Cotton Mills employ about 2,000 operatives, and all sewage and manufacturing wastes from the mills and some sewage from the houses belonging to the company are turned directly into the stream.

The population in the valley of the river above these mills is small, amounting in 1885 to but 72 persons per square mile. Water for use in the mill and the houses in the vicinity is pumped directly from the river.

An examination of the portion of the Nashua River basin in Massachusetts was made by the State Board of Health in 1876, the results of which are published in the eighth annual report of the Board, January, 1877, pp. 21–67. The following table taken from page 35 of that report gives a summary of the manufacturing at that time: —

MANUFACTURES.	Number.	Operatives Employed.
Woolen mills,	14	1,265
Shoddy mills,	2	6
Cotton mills,	22	2,478
Paper mills,	20	437
Edge-tool and machine works,	6	350
Comb manufactories,	9	330
Tanneries,	4	180
Chair and tub manufactories,	3	245
Leather-board mills,	5	94
Flour mills,	2	14
Gas works,	2	6
Linen mill,	1	22
Wood pulp mill,	1	6
Cotton and shoddy mill,	1	10
Totals,	92	5,443

Examinations of the water of the south branch of the Nashua River above Clinton were made monthly from June, 1887, to May, 1889, inclusive, and similar examinations of the main river at Mine Falls above Nashua, N. H., were made from June, 1887, to December, 1888, inclusive. The results of these analyses are given in the appended tables. Records of the flow of the river were kept at the Lancaster Mills, Clinton, and at the Jackson Company's Mills at Nashua from October, 1887, to December, 1888. The records of volumes flowing per square mile of watershed at the former place differ widely from those at the latter and at other places in the State, and the results are therefore not published. The volumes flowing at Nashua are given in an appended table after the analyses.

A special examination of the north and south branches of the river was made Sept. 14–17, 1888, the results of which are given in full in the tables of analyses. The amount of free ammonia,

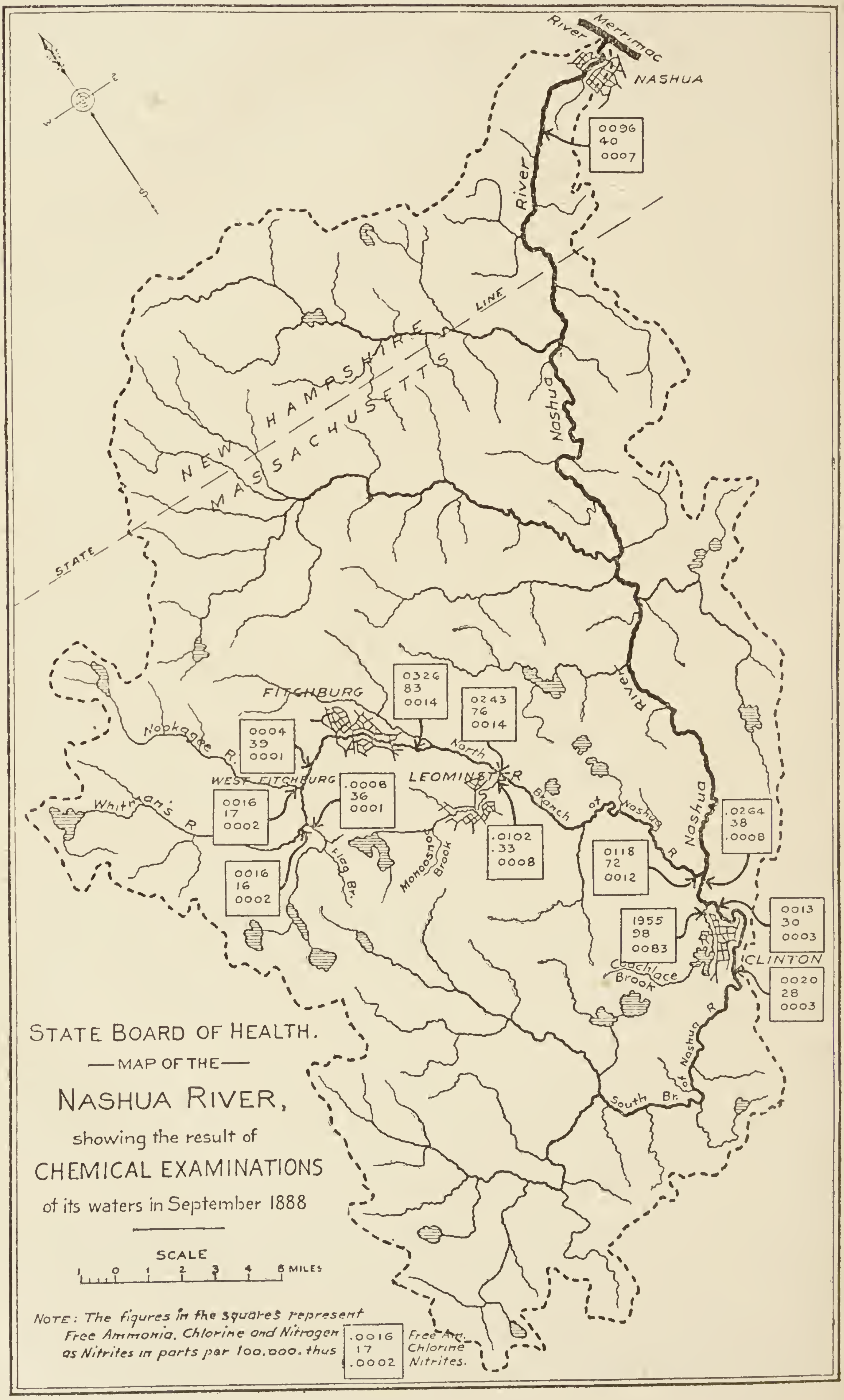
chlorine, and nitrogen as nitrites at each point is shown on the map on page 472, the figures given being in many cases averages of several samples. At the time the special examination of the river was made, the flow of the river was small, but it was by no means an unusually low dry weather flow. The examinations in the vicinity of Clinton and at the mouth of the branches were made on Monday, and the results may differ somewhat from those which would be obtained later in the week, on account of the unusual conditions which exist on Sunday when the water of the river is held back to a large extent in mill ponds.

The four samples above Fitchburg serve to indicate the character of the water of the north branch before polluting material has been turned into it at Fitchburg. The samples collected below Fitchburg indicate the character of the water after receiving the domestic and manufacturing sewage of this city. The samples collected at North Leominster show, by comparison with those taken above, the change that has taken place in the character of the water after flowing about two miles with a sluggish current and being diluted with about 30 per cent. of its volume of comparatively pure water. In like manner the samples from the mouth of Monoosnoc Brook show the extent to which this stream is polluted; and those taken near the mouth of the north branch show, by comparison with those taken next above, the change in the character of the water due to flowing ten miles and being diluted with the flow from 57 per cent. more drainage area.

The samples from the south branch at Cunningham's Bridge, above Clinton, represent the water of this stream where it has received only a comparatively small amount of sewage and manufacturing refuse; those taken above the mouth of Coachlace Brook were affected by the Lancaster Mills and a small portion of the population of Clinton; while those taken near the confluence with the north branch were affected by all of the sewage and manufacturing wastes turned into the stream at Clinton. The samples from Coachlace Brook at its mouth were affected by the sewage of a large part of Clinton and that of the Bigelow Carpet Company.

The samples collected from the main river above Nashua represent the character of the water as it leaves the State and before any sewage has been turned into it at Nashua.

The examinations of the water of the south branch above Clinton show that it is naturally a very good, soft water, having compara-



Merrimac River
NASHUA
Nashua River
NEW HAMPSHIRE
MASSACHUSETTS
STATE LINE
FITCHBURG
Nookagee R.
WEST FITCHBURG
Whitman's R
LEOMINSTER
North Branch of Nashua R
Monoosnoc Brook
Fall Br.
CLINTON
Coachlace Brook
South Br. of Nashua R
0096 40 0007
0326 83 0014
0243 76 0014
0004 39 0001
.0008 36 0001
0016 17 0002
0016 16 0002
.0102 .33 0008
0118 72 0012
.0264 38 .0008
1955 98 0083
0013 30 0003
0020 28 0003
STATE BOARD OF HEALTH.
MAP OF THE
NASHUA RIVER,
showing the result of
CHEMICAL EXAMINATIONS
of its waters in September 1888
SCALE
1 0 1 2 3 4 5 MILES
NOTE: The figures in the squares represent Free Ammonia, Chlorine and Nitrogen as Nitrites in parts per 100,000. thus
.0016 17 .0002
Free Am. Chlorine Nitrites.

tively little color and that it is not polluted to any considerable extent. The water below the Lancaster Mills and above the mouth of Coachlace Brook varied little in quality from that taken above the mills. The water from Coachlace Brook was extremely foul, and that from the mouth of the south branch, below this brook, was much polluted.

The water of the north branch is seriously polluted at all points below Fitchburg. Just below the city it is worse than at any other place on this branch, and also worse than at any point on the south branch, though not nearly as bad as the water of Coachlace Brook. From below Fitchburg to the mouth of the branch the analyses show a progressive improvement in the quality of the water, and at the latter place it was less polluted when the samples were taken than the water of the south branch. The water of Monoosnoc Brook was polluted to a considerable extent, though less than the stream into which it empties.

The water above Nashua is of much better quality than at the confluence of the branches, though, except at times of high flow, the fact that the water is polluted can easily be detected by chemical analyses.

Examinations of other surface waters in the Nashua River basin have been made and are given in the preceding portion of this report as follows: —

Ashburnham, Storage Reservoir, ... page 18
Ayer, Sandy Pond, ... page 28
Clinton, Water Works Reservoirs, ... pages 102-104
Clinton, Heywood's Pond, ... page 104
Leominster, Haynes Reservoir, ... page 188
Leominster, Morse Reservoir, ... page 189

Chemical Examination of Water from the Tributaries of the North Branch of the Nashua River above Fitchburg.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
3171	Sept. 14	Sept. 15	Slight.	Consid'ble.	0.50	4.95	1.55	3.40	.0008	.0268 .0210	.36	.0050	.0001
3172	Sept. 14	Sept. 15	Very slight.	Slight.	0.65	4.10	1.90	2.20	.0016	.0262 .0204	.16	.0070	.0002

Chemical Examination of Water from the Tributaries of the North Branch of the Nashua River above Fitchburg — Concluded.

Number.	Date of: Collection.	Date of: Examination.	Appearance: Turbidity.	Appearance: Sediment.	Appearance: Color.	Residue on Evaporation: Total.	Residue on Evaporation: Loss on Ignition.	Residue on Evaporation: Fixed.	Ammonia: Free.	Ammonia: Albuminoid.	Chlorine.	Nitrogen as: Nitrates.	Nitrogen as: Nitrites.
	1888.												
3173	Sept. 14	Sept. 15	Very slight.	Very slight.	0.40	3.35	1.20	2.15	.0016	.0168	.17	.0070	.0002
3174	Sept. 14	Sept. 15	None.	Very slight.	0.10	6.65	1.40	5.25	.0004	.0168	.39	.0050	.0001

Odor of 3171, 3172, 3173, none; of 3174, faintly musty.——Sample No. 3171 was collected from Flag Brook just above its confluence with Whitmans River. Sample No. 3172 was collected from Whitmans River just above its confluence with Flag Brook at Crockerville. Sample No. 3173 was collected from Nookagee River just above its confluence with the Nashua River at West Fitchburg. Sample No. 3174 was collected from the Nashua River at Wallace's Paper Mill, West Fitchburg.

Chemical Examination of Water from the North Branch of the Nashua River below Fitchburg.

[Parts per 100,000.]

Number.	Date of: Collection.	Date of: Examination.	Appearance: Turbidity.	Appearance: Sediment.	Appearance: Color.	Residue on Evaporation: Total.	Residue on Evaporation: Loss on Ignition.	Residue on Evaporation: Fixed.	Ammonia: Free.	Ammonia: Albuminoid.	Chlorine.	Nitrogen as: Nitrates.	Nitrogen as: Nitrites.
	1888.												
3177	Sept. 14	Sept. 15	Decided.	H'vy, e'rthy and floc't.	1.2	9.35	2.65	6.70	.0312	.0502 .0362	.76	.0080	.0014
3176	Sept. 14	Sept. 15	Decided.	H'vy, e'rthy and floc't.	1.0	10.85	3.40	7.45	.0312	.0600 .0454	.83	.0150	.0018
3178	Sept. 14	Sept. 15	Decided.	H'vy, e'rthy and floc't.	1.0	10.30	2.60	7.70	.0342	.0704 .0462	.88	.0090	.0012
3180	Sept. 14	Sept. 15	Decided.	Con., e'rthy and floc't.	0.8	9.85	2.05	7.80	.0338	.0516 .0398	.83	.0120	.0013
Av.	....	....	....	....	1.0	10.09	2.67	7.41	.0326	.0580 .0419	.83	.0110	.0014

Odor of all four samples, musty.——The samples were collected from the river below Fitchburg, near the boundary between Fitchburg and Leominster. The samples were collected at intervals through the day as follows: No. 3177 at 8 A.M., No. 3176 at 11 A.M, No. 3178 at 1.15 P.M., No. 3180 at 4 15 P.M.

Microscopical Examination.

	No. 3177.	No. 3176.	No. 3178.	No. 3180.
1. Blue-green Algæ, ...	0.0	pr.	pr.	pr.
2. Other Algæ, ...	pr.	0.3	0.4	pr.
3. Fungi, ...	pr.	0.1	5.2	10.0
4. Animal Forms, ...	pr.	0.0	0.0	0.3

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Diatomaceæ. 3. Schizomycetes, *Crenothrix*. 4. Protozoa; Entomostraca

Chemical Examination of Water from the North Branch of the Nashua River at Leominster.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
3184	Sept. 15	Sept. 17	Slight.	Con., e'rthy and floc't.	0.7	8.80	2.30	6.50	.0274	.0390 .0296	.75	.0100	.0015
3181	Sept. 15	Sept. 17	Slight.	Con., brown, fibrous.	0.5	8.20	2.15	6.05	.0212	.0290 .0218	.76	.0150	.0013
Av.	....	....	....	....	0.6	8.50	2.22	6.27	.0243	.0340 .0257	.76	.0125	.0014

Odor of 3184, vegetable and musty; of 3181, faintly vegetable.—— The samples were collected from the river just above the bridge at North Leominster. No. 3184 was collected at 10.30 A.M. and No. 3181 at 3 P.M.

Microscopical Examination.

No. 3184. 1. Blue-green algæ, pr.; 2. Other algæ, 0.2; 3. Fungi, 0.0; 4. Animal forms, pr.

No. 3181. 1. Blue-green algæ, pr.; 2. Other algæ, 0.5; 3. Fungi, 0.0; 4. Animal forms, 0.2.

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Diatomaceæ. 4. Protozoa; Nematoda; Rotifera; Entomostraca.

Chemical Examination of Water from Monoosnoc Brook at Leominster.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
3182	Sept. 15	Sept. 17	Distinct.	Con., e'rthy and floc't.	0.7	4.35	2.10	2.25	.0092	.0324 .0252	.32	.0250	.0006
3183	Sept. 15	Sept. 17	Slight.	Con., e'rthy and floc't.	0.6	4.15	1.80	2.35	.0112	.0330 .0216	.34	.0280	.0009
Av.	... .	....	....	....	0.6	4.25	1.95	2.30	.0102	.0327 .0234	.33	.0265	.0008

Odor of 3182, musty; of 3183, faintly vegetable.—— The samples were collected from the brook near its confluence with the north branch of the Nashua River below North Leominster. No. 3182 was collected at 10 A.M. and No. 3183 was collected at 2.30 P.M.

Microscopical Examination.

No. 3182. 1. Blue-green algæ, 0.2; 2. Other algæ, 1.6; 3. Fungi, 0.0; 4. Animal forms, pr.

No. 3183. 1. Blue-green algæ, pr.; 2. Other algæ, 2.0; 3. Fungi, 0.3; 4. Animal forms, pr.

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Asterionella*. 3. Schizomycetes. 4. Protozoa; Rotifera.

Chemical Examination of Water from the North Branch of the Nashua River just above its Confluence with the South Branch at Lancaster.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
3204	Sept. 17	Sept. 19	Distinct.	Slight.	0.60	7.40	1.90	5.50	.0122	.0288 .0250	.73	.0250	.0012
3206	Sept. 17	Sept. 19	Very slight.	Slight.	0.50	7.45	1.70	5.75	.0130	.0298 .0296	.72	.0280	.0010
3207	Sept. 17	Sept. 19	Very slight.	Slight.	0.65	7.60	1.90	5.70	.0124	.0276 .0254	.71	.0220	.0012
3193	Sept. 17	Sept. 18	Slight.	Slight.	0.50	7.45	1.80	5.65	.0096	.0288 .0244	.72	.0280	.0013
Av.	....	....	....	....	0.56	7.47	1.82	5.65	.0118	.0287 .0261	.72	.0257	.0012

Odor, faintly musty.—The samples were collected from the north branch of the Nashua River at the railroad bridge, about one-third of a mile above the confluence of the north and south branches, as follows: No. 3204 at 10.50 A.M., No. 3206 at 1.15 P.M., No. 3207 at 3 P.M., No. 3193 at 3.50 P.M.

Microscopical Examination.

	No. 3204.	No. 3206.	No. 3207.	No. 3193.
1. Blue-green Algæ, ...	0.0	0.0	0.0	pr.
2. Other Algæ, ...	1.4	1.8	2.9	4.8
3. Fungi, ...	pr.	0.0	0.0	0.0
4. Animal Forms, ...	pr.	0.2	pr.	pr.

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Synedra*. 3. Schizomycetes. 4. Protozoa; Spongiaria; Nematoda.

Chemical Examination of Water from the South Branch of the Nashua River above Clinton.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Exam-ination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albu-minoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
186	June 23	June 24	Veryslight.	Slight.	0.30	4.23	1.17	3.06	.0018	.0175	.25	.0060	–
416	July 26	July 28	Slight.	Veryslight.	1.20	4.48	1.52	2.96	.0032	.0340	.15	.0130	–
611	Aug. 24	Aug. 25	Slight.	Slight.	0.90	4.15	1.43	2.72	.0020	.0239	.12	.0050	–
839	Sept. 21	Sept. 22	Veryslight.	Veryslight.	0.40	3.90	1.05	2.85	.0012	.0166	.19	.0080	–
1007	Oct. 20	Oct. 22	Slight.	Slight.	0.40	4.30	1.00	3.30	.0008	.0216	.27	.0080	–
1239	Nov. 21	Nov. 22	Slight.	Veryslight.	0.55	4.05	1.40	2.65	.0008	.0196	.25	.0060	–
1470	Dec. 21	Dec. 22	Distinct.	Slight.	0.30	3.85	1.10	2.75	.0008	.0180	.22	.0080	–
	1888.												
1605	Jan. 16	Jan. 17	Distinct.	Slight.	0.20	3.45	1.15	2.30	.0029	.0220	.13	.0150	.0000
1815	Feb. 13	Feb. 14	Veryslight.	Veryslight.	0.35	3.45	0.75	2.70	.0012	.0122	.22	.0150	.0000
2005	Mar. 12	Mar. 15	None.	Veryslight.	0.10	4.25	0.55	3.70	.0000	.0056	.15	.0150	.0001
2233	Apr. 16	Apr. 17	Distinct.	Slight.	0.30	2.45	0.85	1.60	.0000	.0129	.14	.0080	.0001
2421	May 14	May 15	Slight.	Slight.	0.60	3.35	1.50	1.85	.0012	.0226	.12	.0050	.0001
2597	June 12	June 13	Veryslight.	Veryslight.	0.10	4.05	0.75	3.30	.0000	.0072	.12	.0100	.0002
2788	July 17	July 18	Slight.	Slight.	0.20	3.80	1.05	2.75	.0002	.0182 **.0144**	.21	.0020	.0001
2936	Aug. 14	Aug. 15	Distinct.	Slight.	0.20	3.85	1.10	2.75	.0016	.0164 **.0124**	.28	.0090	.0002
3195	Sept. 17	Sept. 18	Veryslight.	Slight.	0.15	3.95	1.15	2.80	.0020	.0202 **.0138**	.28	.0070	.0003
3381	Oct. 16	Oct. 18	Slight.	Slight.	0.90	3.65	1.60	2.05	.0002	.0174 **.0160**	.19	.0080	.0001
3553	Nov. 15	Nov. 16	Slight.	Veryslight.	0.60	3.40	1.45	1.95	.0004	.0138	.18	.0150	.0003
3711	Dec. 13	Dec. 14	Slight.	Slight.	0.20	2.75	0.85	1.90	.0004	.0124 **.0108**	.19	.0070	.0001
	1889.												
3861	Jan. 15	Jan. 17	Veryslight.	Veryslight.	0.20	2.95	0.85	2.10	.0000	.0180 **.0154**	.18	.0100	.0001
4042	Feb. 19	Feb. 20	Decided.	Consid'ble.	0.30	3.30	1.00	2.30	.0008	.0188 **.0166**	.21	.0090	.0002
4351	Mar. 19	Mar. 20	Slight.	Veryslight.	0.20	2.60	0.70	1.90	.0000	.0134 **.0100**	.16	.0050	.0002
4531	Apr. 16	Apr. 18	Veryslight.	Slight.	0.20	2.75	0.75	2.00	.0006	.0138 **.0112**	.18	.0040	.0002
4668	May 14	May 15	Slight.	Consid'ble.	0.30	3.20	1.05	2.15	.0008	.0174 **.0134**	.17	.0030	.0001
Av.	....	....	....	....	0.38	3.83	1.12	2.70	.0010	.0172	.19	.0084	.0001

Hardness in May, 1888, 1.1. Odor, faintly vegetable, occasionally mouldy.——The samples were collected from the river at Cunningham's Bridge about two miles above Clinton.

Microscopical Examination.

	1888.							1889.					
	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ,	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ,	1.3	2.7	4.0	1.7	0.8	pr.	0.5	0.1	1.1	0.6	0.5	1.0
3. Fungi,	0.0	0.6	0.1	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms,	0.1	3.0	0.1	0.2	pr.	0.1	pr.	pr.	pr.	0.1	0.0	0.2

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Melosira;* Zygnemaceæ. 3. Schizomycetes. 4. Protozoa, *Dinobryon;* Spongiaria; Rotifera; Entomostraca.

Chemical Examination of Water from the South Branch of the Nashua River at Clinton, above the Mouth of Coachlace Brook.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
3190	Sept. 17	Sept. 18	Very slight.	Slight.	0.2	4.00	1.30	2.70	.0020	.0188 .0148	.29	.0070	.0003
3205	Sept. 17	Sept. 19	Slight.	Slight.	0.2	3.75	1.00	2.75	.0006	.0188 .0146	.30	.0080	.0003
Av.	....	....	....	....	0.2	3.87	1.15	2.72	.0013	.0188 .0147	.30	.0075	.0003

Odor, faintly vegetable.——The samples were collected from the river opposite the corner of High and Allen streets; No. 3190 was collected at 11.35 A.M. Sample No. 3205 was collected at 2.30 P.M.

Microscopical Examination.

No. 3190. 1. Blue-green algæ, pr.; 2. Other algæ, 2.9; 3. Fungi, 0.0; 4. Animal forms, 0.3.

No. 3205. 1. Blue-green algæ, 0.0; 2. Other algæ, 1.1; 3. Fungi, pr.; 4. Animal forms, pr.

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ, *Chlorococcus;* Zoosporeæ; Desmidiaceæ; Diatomaceæ. 3. Schizomycetes. 4. Protozoa; Rotifera.

Chemical Examination of Water from Coachlace Brook at Clinton.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
3202	Sept. 17	Sept. 19	Slight.	Con., e'rthy and floc't.	0.35	9.65	1.90	7.75	.2280	.0620 .0440	1.00	.0180	.0056
3189	Sept. 17	Sept. 18	Slight.	Con., e'rthy and floc't.	0.23	8.90	1.65	7.25	.2200	.0520 .0450	0.95	.0330	.0033
3191	Sept. 17	Sept. 18	Distinct.	Con., e'rthy and floc't.	0.20	9.45	1.85	7.60	.1720	.0710 .0580	0.99	.0200	.0044
3194	Sept. 17	Sept. 18	Decided.	Con., e'rthy and floc't.	0.40	11.00	2.75	8.25	.1620	.0786 .0476	0.97	.0050	.0200
Av.	....	....	....	....	0.29	9.75	2.04	7.71	.1955	.0659 .0487	0.98	.0190	.0083

Odor, offensive.——The samples were collected from Coachlace Brook, near the point where it flows into the Nashua River, as follows: No. 3202 was collected at 9.45 A.M., No. 3189 at 11.30 A.M., No. 3191 at 2.40 P.M., No. 3194 at 4.10 P.M.

Microscopical Examination.

	No. 3202.	No. 3189.	No. 3191.	No. 3194.
1. Blue-green Algæ, ...	0.3	0.6	pr.	0.2
2. Other Algæ, ...	0.2	0.5	0.4	0.6
3. Fungi, ...	1.5	0.8	1.0	pr.
4. Animal Forms, ...	0.2	0.6	pr.	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ. 3. Schizomycetes, *Crenothrix*. 4. Protozoa; Rotifera; Nematoda.

Chemical Examination of Water from the South Branch of the Nashua River just above its Confluence with the North Branch at Lancaster.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
3203	Sept. 17	Sept. 19	Slight.	Consid'ble.	0.2	5.25	1.45	3.80	.0444	.0286 .0184	.41	.0180	.0010
3208	Sept. 17	Sept. 19	Slight.	Consid'ble.	0.2	5.25	0.95	4.30	.0310	.0212 .0166	.40	.0180	.0008

Chemical Examination of Water from the South Branch of the Nashua River just above its Confluence with the North Branch at Lancaster — Concluded.

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.	Chlorine.	Nitrates.	Nitrites.
	1888.												
3209	Sept. 17	Sept. 19	Slight.	Slight.	0.2	4.85	0.95	3.90	.0166	.0208 .0156	.36	.0230	.0007
3192	Sept. 17	Sept. 18	Very slight.	Slight.	0.2	4.30	1.10	3.20	.0136	.0216 .0184	.35	.0180	.0006
Av.	....	....	....	....	0.2	4.91	1.11	3.80	.0264	.0230 .0173	.38	.0192	.0008

Odor, generally musty.—— The samples were collected from the river, just above its confluence with the north branch, as follows: No. 3203 was collected at 10.20 A.M., No. 3208 at 12.30 P.M., No. 3209 at 2.30 P.M., No. 3192 at 3.30 P.M.

Microscopical Examination.

	1888.			
	No. 3203.	No. 3208.	No. 3209.	No. 3192.
1. Blue-green Algæ, ...	0.0	pr.	0.2	pr.
2. Other Algæ, ...	4.2	6.0	3.7	6.2
3. Fungi, ...	0.6	pr.	0.0	pr.
4. Animal Forms, ...	0.4	0.2	pr.	0.1

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ, *Scenedesmus;* Desmidiaceæ; Diatomaceæ, *Navicula, Synedra.* 3. Schizomycetes. 4. Protozoa; Nematoda.

Chemical Examination of Water from the Nashua River at Nashua, N. H.

[Parts per 100,000.]

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.	Chlorine.	Nitrates.	Nitrites.
	1887.												
91	June 14	June 15	None.	Con., brown.	0.40	4.87	2.00	2.87	.0066	.0185	.43	.0070	–
319	July 12	July 13	Slight.	Con., brown.	0.50	5.00	1.35	3.65	.0022	.0245	.38	.0070	–
562	Aug. 15	Aug. 17	Slight.	Sli't, earthy.	0.70	4.92	1.00	3.92	.0039	.0193	.29	.0100	–
768	Sept. 13	Sept. 15	Distinct.	Sli't, e'rthy.	0.20	4.90	0.85	4.05	.0026	.0191	.29	.0070	–
979	Oct. 18	Oct. 19	Slight.	Slight.	0.60	5.45	1.30	4.15	.0054	.0196	.35	.0090	–

Chemical Examination of Water from the Nashua River at Nashua, N. H. —Concluded.

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.	Chlorine.	Nitrates.	Nitrites.
	1887.												
1199	Nov. 15	Nov. 16	Decided.	Slight.	0.40	5.55	1.30	4.25	.0039	.0214	.41	.0090	-
1423	Dec. 15	Dec. 16	Distinct.	Slight.	0.45	4.35	1.20	3.15	.0027	.0195	.28	.0100	-
	1888.												
1641	Jan. 18	Jan. 20	Slight.	Very slight.	0.10	4.55	1.10	3.45	.0002	.0095	.22	.0250	-
1850	Feb. 15	Feb. 17	Distinct.	Sli't, white.	0.35	4.80	1.15	3.65	.0004	.0169	.25	.0120	.0001
2036	Mar. 15	Mar. 19	Distinct.	Slight.	0.20	4.20	0.85	3.35	.0019	.0148	.24	.0090	.0001
2261	Apr. 18	Apr. 20	Slight.	Sli't, brown.	0.20	3.10	1.00	2.10	.0002	.0114	.18	.0080	.0002
2454	May 16	May 18	Very slight.	Sli't, brown.	0.40	3.25	1.20	2.05	.0004	.0178	.17	.0050	.0001
2615	June 14	June 16	Very slight.	Sli't, rusty brown.	0.40	4.15	1.00	3.15	.0034	.0172 .0158	.27	.0070	.0003
2806	July 19	July 20	Slight.	Sli't, brown.	0.30	4.65	0.80	3.85	.0052	.0198 .0136	.35	.0070	.0003
2953	Aug. 15	Aug. 17	Slight.	Sli't, brown.	0.40	5.35	1.30	4.05	.0044	.0176 .0152	.41	.0100	.0003
3226	Sept. 20	Sept. 21	Slight.	Sli't, brown.	0.50	5.55	1.65	3.90	.0096	.0300 .0254	.40	.0120	.0007
3394	Oct. 17	Oct. 19	Very slight.	Sli't, earthy and floc't.	0.60	4.20	1.25	2.95	.0008	.0168 .0154	.22	.0150	.0004
3554	Nov. 15	Nov. 16	Slight.	Sli't, white.	0.50	4.00	1.20	2.80	.0016	.0258 .0188	.24	.0150	.0003
3704	Dec. 11	Dec. 13	Distinct.	Sli't, white.	0.15	3.55	1.05	2.50	.0006	.0166 .0134	.25	.0100	.0002
Av.	....	....	....	....	0.38	4.58	1.19	3.39	.0029	.0187	.29	.0102	.0003

Hardness in May, 1888, 1.3. Odor, generally vegetable.——The samples were collected from the river at Mine Falls. There were heavy rains just previous to the collection of Nos. 319, 1199 and 3226.

Microscopical Examination.

	1888.						
	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1. Blue-green Algæ,	0.0	0.0	0.0	pr.	0.0	0.0	0.0
2. Other Algæ,	4.5	1.3	1.8	2.2	0.9	1.0	0.2
3. Fungi,	1.5	0.7	0.2	pr.	0.3	0.0	0.0
4. Animal Forms,	pr.	0.0	pr.	0.1	pr.	0.2	pr.

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ, *Raphidium;* Desmidiaceæ; Diatomaceæ. 3. Schizomycetes, *Crenothrix.* 4. Protozoa; Spongiaria; Annelida; Rotifera; Entomostraca.

Table showing the Flow of the Nashua River at the Dam of the Jackson Co., Nashua, N. H.

MONTH.	Day on which the Sample was collected for Analysis at Clinton.	Day on which the Sample was collected for Analysis at Nashua.	Flow during Working Hours on the Day the Sample was collected at Clinton. Cu. ft. per sec.	Flow during Working Hours on the Day the Sample was collected at Nashua. Cu. ft. per sec.	Average Flow during Working Hours for the Month. Cu. ft. per sec.
1887.					
October,	20	18	537	568	601
November,	21	15	851	665	718
December,	21	15	859	947	851
1888.					
January,	16	18	637	806	768
February,	13	15	608	659	1,112
March,	12	15	568	568	1,327
April,	16	18	2,293	2,018	2,117
May,	14	16	2,532	1,784	1,200
June,	12	14	718	719	688
July,	17	19	618	468	668
August,	14	15	797	849	692
September,	17	20	680	1,556	1,224
October,	16	17	2,399	2,503	2,535
November,	15	15	598	-	-
December,	13	11	1,911	1,643	2,073

Neponset River.

The Neponset River basin lies to the south-east of the Charles River basin and occupies the central part of Norfolk County. It rises in the Neponset Reservoir in the town of Foxborough, and flows thence in a generally north-easterly direction to Dorchester Bay, draining an area of 114.1 square miles.

At Hyde Park the river is joined by its principal tributary, Mother Brook, which has a comparatively small watershed of its own, but is legally entitled to receive at its upper end one-third of the water flowing in Charles River. It may therefore be considered as having, in addition to its own watershed, one-third of that of the Charles River above it, equal to 66.2 square miles.

The watershed of the Neponset River is generally a hilly and rolling country, some of the hills, notably those in the Blue Hill

range, being high and steep. Between Norwood and Hyde Park, the river for more than seven miles meanders with a sluggish current through very extensive meadows and swamps which are generally wet throughout the year. There are also swamp and meadow lands in other portions of the watershed and several large ponds, which store considerable water and tend to keep up the dry weather flow of the stream. The total storage capacity is, however, comparatively small, and the stream becomes very low in dry seasons. The fall of the stream is considerable, being over 260 feet from Neponset Reservoir to its mouth, a distance of 25 miles; by far the greater part of this fall occurs above the great meadows.

The water of the river is not used directly for domestic water supply, but the Hyde Park Water Company obtains water for supplying the town from tubular wells driven near the river a short distance above the mouth of Mother Brook.

Above these wells the river drains an area of 94.8 square miles, which contained in 1885 a population of 15,270, equal to 161 persons per square mile. Below this point the population is much more dense, and is growing rapidly on account of its proximity to Boston.

The valley contains the whole or a considerable portion of nine cities and towns, eight of which have public water supplies. None of them, however, have public sewers except Boston, which has in the aggregate five miles in the Dorchester District discharging directly into the tidal portion of the river.

Careful examinations of the valley, with reference to the pollution of the streams, were made by the State Board of Health in 1875, and by the Massachusetts Drainage Commission in 1885. The results of the former are given in the Seventh Annual Report of the Board, January, 1876, pp. 89–97; and the latter in the report of the Commission, pp. 76–95. These examinations show that the water power of the streams has been quite completely developed and that there is a very large amount of manufacturing, particularly in the upper portions of the valley, in proportion to the size of the streams; also, that the factories in many cases discharge much objectionable refuse.

The following table, compiled from the report of the Commission, gives a summary of the manufacturing in the valley in 1885: —

MANUFACTURES.	Number.	Operatives Employed.
Woolen mills,	9	1,138
Cotton mills,	9	641
Paper mills,	7	275
Silk mills,	1	150
Emery mills,	1	20
Iron and metal works,	7	619
Stove polish works,	1	40
Rubber works,	1	50
Paint works,	1	4
Printing ink works,	1	16
Chocolate factory,	1	200
Curled hair factory,	1	130
Bleachery,	1	22
Tanneries,	2	250
Dye and color works,	1	18
Totals,	44	3,573

NOTE.— In addition to the above there are a starch factory, dye works and several shoe factories in the valley, in which the number of operatives is not given.

Wool is scoured at seven of the nine woolen mills. At the wool-scouring mill of E. F. Lewis in Walpole, nearly as much wool was scoured in 1885 as at all the other mills in the valley, and on account of the objection to the pollution of the stream by the refuse from the mill the business has recently (1890) been removed from the valley.

Examinations of the water of the river opposite the wells of the Hyde Park Water Company were made monthly from June, 1887, to May, 1889, inclusive, and measurements of the flow of the river at Mattapan were made during the months of October, November and December, 1887; the results are given in the appended tables. The flow of Mother Brook from October, 1887, to December, 1888, is given on page 405.

Examinations of other surface waters in the Neponset basin have been made, and are given in the preceding portion of this report, as follows: —

Canton, York Pond, ... page 94
Hyde Park, Sprague Pond, ... page 167
Norwood, Buckmaster Pond, ... page 260
Sharon, Mann's Pond, ... page 291

The examinations of the Massachusetts Drainage Commission showed that a part of the upper portion of the river and its tributary brooks were badly polluted by the discharge of manufacturing sewage, chiefly from wool-scouring mills, tanneries and dyeworks, and their waters were thereby rendered unfit for use in some manufacturing operations.

Opposite the wells of the Hyde Park Water Company the pollution was said to be noticeable to the eye. The analyses given below also show that the amount of pollution at this point is considerable, notwithstanding the fact that the flow of the river was never very low during the time covered by these examinations.

A branch sewer of the main drainage works of Boston is now being built to protect the lower portion of the river from pollution by the sewage of Dorchester.

Chemical Examination of Water from the Neponset River above Hyde Park.

[Parts per 100,000.]

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.
	1887.												
83	June 10	June 11	Slight.	Consid'ble.	2.00	6.80	3.00	3.80	.0044	.0487	0.68	.0070	–
297	July 11	July 11	Slight.	None.	1.00	5.95	1.75	4.20	.0069	.0432	0.58	.0000	–
511	Aug. 9	Aug. 10	Very slight.	Much, rusty brown.	1.60	9.07	2.55	6.52	.0062	.0509	0.93	.0070	–
721	Sept. 9	Sept. 9	Very slight.	Slight.	0.70	7.37	1.72	5.65	.0039	.0256	0.74	.0130	–
926	Oct. 11	Oct. 11	Decided.	Slight.	0.80	8.75	1.50	7.25	.0094	.0370	1.28	.0100	–
1133	Nov. 9	Nov. 10	Decided.	Slight.	1.00	11.25	2.80	8.45	.0009	.0358	1.66	.0090	–
1384	Dec. 12	Dec. 13	Distinct.	Con., e'rthy and floc't.	1.20	9.25	2.75	6.50	.0056	.0388	1.09	.0100	–
	1888.												
1656	Jan. 19	Jan. 23	Distinct.	Consid'ble, earthy.	1.00	7.30	2.65	4.65	.0011	.0303	0.67	.0200	.0000
1801	Feb. 10	Feb. 13	Distinct.	Con., e'rthy and floc't.	0.70	6.55	2.60	3.95	.0007	.0283	0.65	.0200	.0000
1983	Mar. 9	Mar. 10	Decided.	Con., e'rthy and floc't.	0.90	7.90	2.45	5.45	.0046	.0372	0.88	.0120	.0003
2183	Apr. 9	Apr. 11	Slight.	Slight, brown.	0.90	4.30	1.65	2.65	.0008	.0288	0.52	.0050	.0000
2368	May 8	May 8	Distinct.	Consid'ble, brown.	1.40	5.85	2.45	3.40	.0056	.0314	0.56	.0080	.0003
2721	July 5	July 6	Slight.	Slight, brown.	0.60	6.70	2.10	4.60	.0052	.0286	0.94	.0070	.0003
2897	Aug. 8	Aug. 9	Slight.	Slight, brown.	0.80	8.95	2.10	6.85	.0034	.0446 .0432	1.42	.0070	.0004

Chemical Examination of Water from the Neponset River above Hyde Park — Con.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
3158	Sept. 11	Sept. 12	Very slight.	Slight, brown.	1.10	11.20	2.55	8.65	.0098	.0430 .0378	1.83	.0090	.0005
3347	Oct. 10	Oct. 11	Very slight.	Slight.	1.50	6.35	2.75	3.60	.0008	.0350 .0328	0.63	.0080	.0002
3535	Nov. 13	Nov. 14	Very slight.	Sli't, e'rthy and floc't.	1.60	5.65	2.35	3.30	.0006	.0344 .0294	0.59	.0060	.0002
3758	Dec. 19	Dec. 20	Slight.	Sli't, e'rthy and floc't.	0.70	3.70	1.35	2.35	.0000	.0150 .0130	0.43	.0030	.0006
	1889.												
3833	Jan. 8	Jan. 10	Slight.	Slight.	0.60	3.60	1.15	2.45	.0006	.0188 .0164	0.47	.0050	.0001
4026	Feb. 15	Feb. 18	Decided.	Slight, earthy.	0.50	5.65	1.55	4.10	.0008	.0254 .0180	0.75	.0110	–
4306	Mar. 13	Mar. 15	Slight.	Very slight.	0.70	5.00	2.00	3.00	.0004	.0240 .0198	0.60	.0030	.0002
4474	Apr. 8	Apr. 9	Distinct.	Consid'ble.	0.60	4.70	1.65	3.05	.0020	.0276 .0236	0.65	.0040	.0002
4622	May 8	May 8	Slight.	Consid'ble.	1.70	5.55	2.50	3.05	.0122	.0392 .0338	0.56	.0040	.0002
Av.	....	....	....	....	1.07	7.53	2.32	5.21	.0037	.0335	0.83	.0082	.0002

Hardness in May, 1888, 1.9. Odor, vegetable, often mouldy. The samples were collected from the Neponset River near the pumping station of the Hyde Park Water Company.

Microscopical Examination.

	1888. July.	Aug.	Sept.	Oct.	Nov.	Dec.	1889. Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ, ...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	0.5	0.9	pr.	0.4	0.2	0.0	0.7	1.0	0.0	2.7	1.2
3. Fungi, ...	4.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, ...	pr.	0.1	0.1	0.6	0.2	0.0	pr.	0.1	0.0	0.0	0.2

Groups and principal genera of organisms observed: 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Fragillaria*, *Synedra;* Zygnemaceæ. 3. Schizomycetes, *Crenothrix*. 4. Protozoa; Spongiaria.

Table showing the Flow of the Neponset River at the Mattapan and Sumner Mill, Mattapan.

MONTH.	Day on which Sample was collected for Analysis at Hyde Park.	Flow During Working Hours on the Day the Sample was collected. Cu. ft. per sec.	Average Flow during Working Hours for the Month. Cu. ft. per sec.
1887.			
October,	11	133	134
November,	9	133	139
December,	12	152	158

NOTE.—The drainage area of the Neponset River at Mattapan is 100.3 square miles; one-third the area of the Charles River at Mother Brook is 66.2 square miles, making the total drainage area at Mattapan 166.5 square miles whenever one-third the water of Charles River is being drawn through Mother Brook.

SHAWSHEEN RIVER.

The Shawsheen River is formed about one mile east of the village of Bedford by the confluence of several brooks which rise in Lexington and Lincoln, and flows thence in a generally north-easterly direction to the Merrimack River, just below the city of Lawrence, draining a territory of 75.4 square miles. This territory is flat in the middle portion and rolling or even hilly near the sources and along the lower portion of the river. The soil is generally sand or gravel. Through the flat territory the river is bordered for a long distance by meadows or swamps, and its flow is very sluggish.

Above Ballardvale, which is nearly seven miles by the river from its mouth, there is little or no manufacturing, while at and below this place the river has considerable fall which is fully utilized for power. There are few ponds on the watershed and its dry weather flow is small.

The portion of the river above the crossing of the old Middlesex Canal, which is just above the Boston & Lowell Railroad, has been proposed as a source of water supply for Boston and cities and towns in its vicinity; but authority to take it has not yet been granted by the Legislature.

The following table gives statistics of drainage area and population at the old Middlesex Canal and at the mouth:—

	Distance above Mouth. Miles.	Drainage Area. Sq. Miles.	Population (1885).	Population per Square Mile.
At Old Middlesex Canal crossing,	12	34.1	3,310	97
At Mouth, Lawrence,	0	75.4	11,182	148

The more important towns in the basin are Andover and Lexington, both of which have public water supplies but no system of sewerage. The former is situated about four miles from the mouth of the river and had in 1885 a population of 5,711, nearly all within this basin ; the latter is situated at the head waters of the river, and a little more than half of its population of 2,718 in 1885 was within the Shawsheen drainage area.

Examinations of water from the river at the old Middlesex Canal were made monthly from June, 1887, to May, 1889, and the results are given in the appended tables.

The water is characterized by its dark color and high albuminoid ammonia, and, although but slightly polluted by the population on its watershed, would not in its present condition be satisfactory for water supply purposes.

Chemical Examination of Water from the Shawsheen River at Wilmington.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Exam-ination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albu-minoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
239	June 30	July 1	None.	None.	0.90	4.92	1.22	3.70	.0013	.0232	.34	.0060	–
438	July 29	July 29	Very slight.	Very slight.	1.50	6.95	2.10	4.85	.0010	.0440	.33	.0000	–
675	Sept. 1	Sept. 2	None.	None.	1.60	7.30	2.75	4.55	.0016	.0431	.36	.0030	–
862	Sept. 30	Oct. 3	None.	None.	0.20	4.00	1.00	3.00	.0005	.0119	.38	.0030	–
1067	Oct. 28	Oct. 29	Very slight.	Slight.	1.30	6.00	2.00	4.00	.0010	.0260	.48	.0030	–
1303	Dec. 1	Dec. 2	Slight.	Slight.	1.40	7.00	2.55	4.45	.0006	.0304	.44	.0070	–
1500	Dec. 28	Dec. 29	Very slight.	Very slight.	1.10	6.50	1.80	4.70	.0005	.0231	.35	.0200	–
	1888.												
1668	Jan. 23	Jan. 24	None.	None.	0.40	5.20	1.20	4.00	.0031	.0139	.29	.0330	.0000
1864	Feb. 20	Feb. 20	Very slight.	Very slight.	0.60	5.50	1.65	3.85	.0042	.0242	.41	.0250	.0001
2054	Mar. 19	Mar. 20	Slight.	Very slight.	0.80	4.35	1.30	3.05	.0002	.0186	.44	.0080	.0001
2251	Apr. 19	Apr. 19	None.	Very slight.	0.90	3.80	1.20	2.60	.0000	.0246	.34	.0080	.0002
2439	May 15	May 17	Distinct.	Slight.	2.10	6.05	2.60	3.45	.0006	.0402	.25	.0050	.0000
2606	June 14	June 15	Very slight.	Con., rusty.	0.80	4.75	1.50	3.25	.0036	.0264 **.0242**	.32	.0070	.0001
2826	July 23	July 25	Very slight.	Very slight.	0.15	3.65	0.65	3.00	.0022	.0164 **.0114**	.33	.0020	.0000
2972	Aug. 17	Aug. 18	Very slight.	Very slight.	1.00	5.50	2.20	3.30	.0000	.0322 **.0316**	.32	.0050	.0000
3241	Sept 20	Sept. 22	Very slight.	Sli't, e'rthy and floc't.	0.70	5.40	2.30	3.10	.0012	.0312 **.0236**	.42	.0020	.0000

Chemical Examination of Water from the Shawsheen River at Wilmington — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
3421	Oct. 21	Oct. 23	Very slight.	None.	1.50	5.90	2.80	3.10	.0004	.0352 .0334	.39	.0020	.0001
3552	Nov. 15	Nov. 16	Very slight.	Very slight.	1.50	6.55	3.00	3.55	.0034	.0500 .0420	.41	.0050	.0002
3733	Dec. 18	Dec. 19	Slight.	Sli't, e'rthy.	0.60	2.70	1.20	1.50	.0000	.0194 .0148	.19	.0100	.0002
	1889.												
3869	Jan. 17	Jan. 19	None.	Very slight.	0.40	3.75	1.30	2.45	.0000	.0152 .0134	.32	.0080	.0003
4083	Feb. 22	Feb. 23	Very slight.	Slight.	0.50	4.00	1.55	2.45	.0002	.0226 .0202	.31	.0200	.0003
4391	Mar. 24	Mar. 25	Very slight.	Very slight.	0.90	4.40	1.70	2.70	.0028	.0270 .0244	.41	.0070	.0002
4532	Apr. 17	Apr. 18	Very slight.	Slight.	1.10	4.60	1.95	2.65	.0002	.0290 .0248	.37	.0060	.0002
4683	May 16	May 17	Slight.	Consid'ble.	1.00	4.75	1.85	2.90	.0136	.0262 .0226	.29	.0080	.0004
Av.	....	....	....	....	0.96	5.63	1.78	3.85	.0018	.0272	.35	.0085	.0001

Hardness in May, 1888, 1.8. Odor, faintly vegetable. —— The samples were collected from the river at the point where it is crossed by the old Middlesex Canal, between the towns of Wilmington and Billerica.

Microscopical Examination.

	1888. June.	1888. July.	1888. Aug.	1888. Sept.	1888. Oct.	1888. Nov.	1888. Dec.	1889. Jan.	1889. Feb.	1889. Mar.	1889. Apr.	1889. May.
1. Blue-green Algæ, ...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	2.2	3.0	0.8	0.4	0.2	0.3	1.5	1.0	0.1	0.4	0.8	0.3
3. Fungi, ...	3.0	10.0	2.1	0.0	0.0	0.0	0.0	pr.	0.0	0.0	0.0	0.0
4. Animal Forms, ...	pr.	0.0	pr.	8.0	0.0	0.5	0.2	0.1	0.0	pr.	0.0	0.0

Groups and principal genera of organisms observed: 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Diatoma*, *Synedra*, *Tabellaria;* Zygnemaceæ. 3. Schizomycetes, *Crenothrix*, *Leptothrix*. 4. Protozoa, *Hydromorum;* Spongiaria; Rotifera; Entomostraca.

Stony Brook (Boston).

This small stream was selected for examination because of the very large population upon its drainage area and because the attempt is made to prevent its pollution. It rises in Muddy Pond, in a very sparsely settled section of the suburbs of Boston, and flows thence through a populated portion of the town of Hyde Park into the West Roxbury District of Boston. In the lower portion of West Roxbury and in Roxbury it flows in a walled channel through a thickly populated territory down to the head of a conduit recently built to carry its flood waters. At this point, and at two points farther up stream, samples of water were collected monthly for analysis from February to May, 1889. An intercepting sewer to carry the dry weather flow of sewage and a portion of the rain water runs nearly parallel with the brook, and is provided with overflows to discharge into it the surplus water during heavy rains.

Statistics regarding the drainage area, and the number of houses connected with the sewers above the three points where samples were collected, are given in the following table: —

	Drainage Area. Sq. Miles.	Estimated Population (1888).	Population per Square Mile.	Number of Houses.	Number of Houses connected with Sewers.	Per Cent. of Houses connected with Sewers.
West Roxbury, just above Neponset Avenue, ...	5.549	8,700	1,564	1,399	549	39
West Roxbury, below Forest Hills Station, ...	9.631	14,500	1,506	2,299	734	32
Roxbury, at head of new conduit, .	12.727	35,000	2,750	5,406	2,975	55

The brook was low for the season of the year when the samples were collected, but not as low as during a dry time in summer.

The analyses given below show that at all of the stations the amount of chlorine and nitrates are above the normal, indicating that filtered sewage reaches the brook. The amount of ammonia found at the upper stations is so small that it is evident that very little sewage enters this portion of the stream directly. The larger amount at the lowest station shows that some sewage enters the lower portion, but the amount is small considering the density of the population.

Chemical Examination of Water from Stony Brook at Mt. Hope Station, West Roxbury.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1889.												
4139	Feb. 27	Feb. 27	Very slight.	Very slight.	0.20	7.20	2.25	4.95	.0080	.0136 .0114	.93	.1100	.0004
4408	Mar. 27	Mar. 27	Very slight.	Very slight.	0.40	6.20	1.65	4.55	.0024	.0202 .0154	.84	.0720	.0004
4554	Apr. 23	Apr. 23	Very slight.	Very slight.	0.80	6.95	2.45	4.50	.0016	.0288 .0248	.74	.0250	.0003
4641	May 11	May 11	Slight.	Consid'ble.	0.90	7.15	2.70	4.45	.0056	.0410 .0340	.70	.0450	.0004
Av.	....	....	....	....	0.57	6.87	2.26	4.61	.0044	.0259 .0214	.80	.0630	.0004

Hardness of 4139, 2.7. Odor, generally none, once mouldy.——The samples were collected from Stony Brook at Neponset Avenue.

Microscopical Examination.

	1889.			
	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ, ...	0.0	0.0	0.0	0.0
2. Other Algæ, ...	0.2	0.2	1.1	2.7
3. Fungi, ...	0.0	0.0	0.0	0.0
4. Animal Forms, ...	pr.	0.0	pr.	0.2

Groups and principal genera of organisms observed: 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Synedra*. 4. Protozoa; Spongiaria.

Chemical Examination of Water from Stony Brook at Forest Hills Station, West Roxbury.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1889.												
4140	Feb. 27	Feb. 27	Very slight.	Very slight.	0.10	7.35	2.35	5.00	.0050	.0124 .0098	.86	.1400	.0003
4409	Mar. 27	Mar. 27	Very slight.	Very slight.	0.20	6.35	1.85	4.50	.0016	.0178 .0166	.77	.0720	.0004

Chemical Examination of Water from Stony Brook at Forest Hills Station, West Roxbury — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
4555	Apr. 23	Apr. 23	Slight.	Slight.	0.60	7.20	2.55	4.65	.0030	.0270 .0234	.78	.0400	.0004
4642	May 11	May 11	Slight.	Con., e'rthy and floc't.	0.70	7.50	2.80	4.70	.0080	.0362 .0236	.72	.0400	.0010
Av.	....	....	....	....	0.40	7.10	2.39	4.71	.0044	.0233 .0198	.78	.0730	.0005

Hardness of 4140, 2.8. Odor, faintly mouldy. —— The samples were collected from the brook between Washington and Morton Streets.

Microscopical Examination.

	1889. Feb.	Mar.	Apr.	May.
1. Blue-green Algæ, ...	0.0	0.0	0.0	0.0
2. Other Algæ, ...	0.3	0.4	2.1	1.1
3. Fungi, ...	0.0	0.0	0.0	0.0
4. Animal Forms, ...	pr.	pr.	pr.	0.0

Groups and principal genera of organisms observed: 2. Palmellaceæ; Desmidiaceæ; Diatomaceæ, *Fragillaria*. 4. Protozoa.

Chemical Examination of Water from Stony Brook at Inlet to New Conduit, Roxbury.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
4141	Feb. 27	Feb. 27	Slight.	Consid'ble.	0.10	11.25	3.55	7.70	.0198	.0168 .0142	1.26	.3500	.0004
4410	Mar. 27	Mar. 27	Slight.	Slight.	0.30	8.55	2.10	6.45	.0144	.0210 .0188	0.97	.0130	.0006
4556	Apr. 23	Apr. 23	Very slight.	Slight.	0.70	8.85	2.55	6.30	.0134	.0266 .0242	0.94	.0600	.0005
4643	May 11	May 11	Slight.	Con., e'rthy and floc't.	0.60	9.40	3.05	6.35	.0174	.0356 .0300	0.93	.0110	.0017
Av.	....	....	....	....	0.42	9.51	2.81	6.70	.0162	.0250 .0218	1.02	.1085	.0008

Hardness of 4141, 4.8. Odor, mouldy and disagreeable. —— The samples were collected at the inlet to the new conduit just above Roxbury Station.

Microscopical Examination.

	1889.			
	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ,	0.0	0.0	0.0	0.0
2. Other Algæ,	0.3	pr.	0.2	5.0
3. Fungi,	0.0	0.0	0.0	0.0
4. Animal Forms,	0.0	0.0	0.0	0.0

Groups and principal genera of organisms observed: 2. Desmidiaceæ; Diatomaceæ, *Synedra*.

Taunton River.

The Taunton River basin occupies the larger part of the south-eastern portion of the State. The river is formed by the confluence of the Town and Matfield rivers, about two miles east of the village of Bridgewater, and flows thence in a circuitous course to Mount Hope Bay at Fall River, its general direction being a little west of south. The lower portion, from East Taunton to the mouth, a distance of 20 miles, is affected by the tides.

The watershed of the Taunton River is for the most part remarkably flat and contains no important elevations, the highest points being at the divide between it and the Neponset. It is, as a whole, well wooded. On the upland pine trees are the most abundant, while in the swamps a heavy growth of cedar is frequently found. The swamps are numerous, and in some cases very extensive, so that they give the water a deep brown color. There are many ponds and reservoirs on the watershed, a few of them being very large, and they serve to increase the dry weather flow, particularly in the Nemasket River and in the main river below it.

The amount of manufacturing in the basin is large, but more of it is done by steam than by water power. The principal manufactures are boots and shoes and metallic and cotton goods; consequently the amount of manufacturing sewage turned into the streams is not very large. Most of the water power is upon the tributaries, as there are but two falls on the main river, one at East Taunton and the other fifteen miles up stream at Paper Mill Village, Bridgewater. The mill pond formed by the lower dam extends nearly to the upper one.

The Taunton River basin was examined by the State Board of Health in 1875 with reference to the pollution of the streams, and

the results are published in the seventh annual report of the Board, pp. 123–142. The most important factories at that time were cotton mills and metal works.

In the basin, as a whole, the population is not very large; but, as many of the larger communities are on the tributaries, there are some streams which receive the drainage from a dense population, and are therefore considerably polluted. The principal cities and towns, including all which have public water supplies, together with their populations and the streams into which they drain, are given in the following table: —

CITY OR TOWN.	Population.		Stream receiving Principal Portion of Drainage.
	1880.	1885.	
Taunton,	21,213	23,674	Mill River.
Brockton,	13,608	20,783	Salisbury Plain River.
Middleborough,	5,237	5,163	Nemasket River.
Easton,	3,902	3,948	Queset River.
Bridgewater,	3,620	3,827	Town River.
Abington,	3,697	3,699	Shumatuscacant River.
Whitman,	3,024	3,595	Shumatuscacant River.
Mansfield,	2,765	2,939	Three Mile River.
East Bridgewater,	2,710	2,812	Matfield River.
Totals,	59,776	70,440	

The streams most affected by sewage are the Salisbury Plain River, just below Brockton, the Mill River in Taunton, and the Shumatuscacant, one of the tributaries of the Satucket, below Whitman.

Monthly examinations of water from the Taunton River at three places, and from its principal tributary, the Nemasket River, at two places, were made from June, 1887, to May, 1889, inclusive, and the results are given in appended tables. Occasional examinations were also made of water from many of the other tributaries. Records of the flow of the river at the Old Colony Iron Works at East Taunton were kept most of the time from October, 1887, to December, 1888; but the results vary so much from those obtained at other streams that they are not published. A careful measurement of the flow of the Nemasket at its mouth and of the main river

just below it, made on July 25, 1888, when the volume flowing was as small as at any time during the year, gave the following results : —

	Total Flow.	Flow per Square Mile.
	Cu. ft. per sec.	Cu. ft. per sec.
Taunton River, below the Nemasket,	138.6	0.54
Nemasket River, at mouth,	56.3	0.78
Taunton River, above the Nemasket,	82.3	0.45

The principal tributaries will now be briefly described in their order going up stream.

The Three Mile River enters the Taunton from the north-west 10.5 miles above its mouth. It receives the drainage from Foxborough, Mansfield and a small part of the city of Taunton. Its waters have not been examined.

The Mill River flows through the city of Taunton and enters the main river fourteen miles above its mouth, draining an area of about forty-seven square miles. There are several important mills on the stream at Taunton, and it receives much sewage from the city sewers and considerable drainage from the gas works. In dry weather the flow of the stream is small, and its waters are much polluted. It is proposed to build a system of sewers to carry the sewage to the main river below the city.

The Nemasket River enters the Taunton twenty-nine miles above its mouth, near the State Farm at Bridgewater. This stream differs from all of the others in that it has at its source several great ponds or lakes, which give it a larger summer flow and supply it with water having less color. The areas of these ponds, as measured from the new State map, are as follows : —

Assawompsett Pond,	2,691 acres.
Long Pond,	1,685 acres.
Great Quittacas Pond,	1,127 acres.
Elder's Pond,	149 acres.
Total,	5,652 acres.

These ponds can be drawn down but two or three feet, but their area is so great that this furnishes a large amount of water for maintaining the summer flow of the river. The town of Middleborough is located on the Nemasket River, about midway between Assawompsett Pond and its mouth. The total length of the river, following its course, is about nine miles. Considerable sewage is discharged into the stream from the village of Middleborough, and much polluting matter from the woolen mill in the town.

The Winetuxet River joins the Taunton about four miles, by river, above the Nemasket. It receives but little artificial pollution, but large areas of swamp drain into it and affect the character of the water.

The Matfield River enters the head of the Taunton and drains an area of 77.1 square miles, with a total population of 32,834, equal to 426 per square mile. Most of the population is on its two principal affluents, namely, in Brockton on the Salisbury Plain River and in Abington and Whitman on the head waters of the Satucket. The waters of both of these streams have been examined, as have also those of Beaver and Meadow brooks. None of the streams present any special features except with regard to the population on their drainage areas, the amount of which is indicated in the table on the following page.

The Town River naturally receives the drainage of Easton, West Bridgewater and Bridgewater. The population per square mile, however, is much less than that upon the drainage area of the Matfield. The water supply for Bridgewater and East Bridgewater is obtained from wells located on the bank of the river in the former town.

The Taunton River is used as a source of water supply for the State Farm at Bridgewater and for the city of Taunton. At the former place the water is taken directly from the river; at the latter it is taken in this way only when the supply from the filter basin is insufficient.

The following table gives statistics regarding the drainage areas and population at different points on the river and its tributaries: —

	Distance above Mouth of River. Miles.	Drainage Area. Sq. Miles.	Population (1885).	Population per Sq. Mile.
Salisbury Plain River, below Brockton, near line between Brockton and West Bridgewater,	42.7	16.0	21,006	1,313
Salisbury Plain River, at mouth,	40.1	20.5	21,418	1,045
Beaver Brook, at mouth,	40.1	9.9	1,072	108
Meadow Brook, at mouth,	39.5	6.4	1,460	228
Shumatuscacant River, one mile below Whitman,	47.2	9.7	5,985	617
Satucket River, at mouth,	37.5	36.5	7,860	215
Matfield River, at mouth,	36.0	77.1	32,834	426
Town River, at mouth,	36.0	60.1	8,741	145
Taunton River, at its head,	36.0	137.2	41,575	303
Winetuxet River, at mouth,	32.7	38.6	1,645	43
Taunton River, just above the mouth of the Nemasket River,	29.0	184.0	43,614	237
Nemasket River, at well of Middleborough Water Works,	36.0	60.9	1,877	31
Nemasket River, at mouth,	29.0	72.2	4,231	59
Taunton River, just below the mouth of the Nemasket,	29.0	256.2	47,845	187
Taunton River, at Old Colony Iron Works, E. Taunton,	20.4	289.1	-	-
Taunton River, opposite Filter Basin of Taunton Water Works,	15.9	312.4	51,943	166
Mill River, at mouth,	14.3	47.0	-	-
Taunton River, at proposed outlet of Taunton sewerage system, about one mile below Weir Village, Taunton,	11.8	364.2	-	-
Taunton River, at mouth (Railroad Bridge at Bowenville, Fall River),	0.0	526.2	-	-

Owing to the character and great area of the swamps on the watershed, the water of the Taunton River has a deeper color than that of any other large river in the State.

Taking the valley as a whole, it may be said that the pollution from manufacturing is much less than that from domestic sewage.

A comparison of the analyses of the Nemasket River water, above and below Middleborough, shows the effect of the polluting matters discharged into the stream, although the difference between the two analyses is not great.

The water of the Nemasket contains less organic matter of vegetable origin and is less polluted than that of the main river into which it discharges, consequently the water in the main river is of better quality below the junction than above it.

The analysis of the river water at the Taunton Water Works is substantially the same as at a point just below the Nemasket, and, notwithstanding the high flow of the river during the two years covered by the investigations, shows to some extent the effect of the population upon the drainage area above.

In addition to the waters whose analyses are given in the appended tables, others in the basin have been examined and the results are given in the preceding portion of this report as follows: —

Brockton, Salisbury Brook, ... page 74
Brockton, Salisbury Brook Reservoir, . . . pages 74-76
Brockton, Center Street Drain, ... page 78
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Chemical Examination of Water from the Salisbury Plain River below Brockton.

[Parts per 100,000.]

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total	Loss on Ignition.	Fixed.	Free.	Albu-minoid.	Chlorine.	Nitrates.	Nitrites.
	1887.												
1049	Oct. 26	Oct. 26	Decided.	Much.	1.30	10.60 9.40	2.90 2.60	7.70 6.80	.0320	.0150	1.21	.0700	-
	1888.												
2824	July 23	July 24	Slight.	Consid'ble.	0.35	8.80	1.75	7.05	.0096	.0218 .0192	1.46	.0980	.0015
3260	Sept. 25	Sept. 26	Slight.	Slight.	1.20	7.65	2.45	5.20	.0166	.0260 .0250	0.95	.0500	.0015
Av.	....	....	....	....	0.95	8.62	2.27	6.35	.0194	.0209	1.21	.0727	.0015

Odor, faintly vegetable or mouldy.——Sample No. 1049 was collected from river at Summer Street. Nos. 2824 and 3260 were collected from river at "Cart Bridge Road," near the boundary between Brockton and West Bridgewater.

Microscopical Examination.

July, 1888. 1. Blue-green algæ, pr.; 2. Other algæ, 1.5; 3. Fungi, 0.0; 4. Animal forms, 0.1.

September, 1888. 1. Blue-green algæ, 0.0; 2. Other algæ, pr.; 3. Fungi, 0.0; 4. Animal forms, 0.1.

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Zoosporeæ; Desmidiaceæ; Diatomaceæ. 3. Protozoa; Spongiaria.

Chemical Examination of Water from the Salisbury Plain River just above its Confluence with Beaver Brook at East Bridgewater.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.		Nitrates.	Nitrites.
	1888.												
2635	June 19	June 20	Slight.	Slight.	1.40	7.50	2.35	5.15	.0112	.0276 .0246	0.95	.0800	.0012
2843	July 24	July 26	Very slight.	Slight.	0.30	8.80	2.10	6.70	.0084	.0216 .0184	1.38	.0750	.0007
3008	Aug. 21	Aug. 22	Slight.	Sli't, rusty.	0.60	8.30	1.95	6.35	.0038	.0236 .0224	1.02	.0250	.0012
Av.	....	....	....	....	0.77	8.20	2.13	6.07	.0078	.0243 .0218	1.12	.0600	.0010

Odor, faintly vegetable or mouldy.—The samples were collected from the river at the first bridge above its confluence with Beaver Brook.

Microscopical Examination.

	1888.		
	June.	July.	Aug.
1. Blue-green Algæ,	0.0	0.0	pr.
2. Other Algæ,	6.2	0.6	1.0
3. Fungi,	3.0	0.5	0.0
4. Animal Forms,	0.2	0.0	pr.

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Synedra*. 3. Schizomycetes, *Leptothrix*. 4. Protozoa.

Chemical Examination of Water from Beaver Brook just above its Confluence with the Salisbury Plain River at East Bridgewater.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.		Nitrates.	Nitrites.
	1888.												
2634	June 19	June 20	Very slight.	Very slight.	2.50	5.30	2.80	2.50	.0020	.0418 .0350	.34	.0080	.0000
2844	July 24	July 26	Slight.	Con., brown.	1.20	7.95	2.75	5.20	.0028	.0436 .0384	.40	.0060	.0002
3007	Aug. 21	Aug. 22	Slight.	Sli't, rusty.	1.10	5.15	2.45	2.70	.0010	.0360 .0322	.38	.0030	.0002
Av.	....	....	....	....	1.60	6.13	2.67	3.46	.0019	.0405 .0352	.37	.0057	.0001

Odor, faintly vegetable.—The samples were collected from the brook at the first bridge above its confluence with the Salisbury Plain River.

Microscopical Examination.

	1888. June.	1888. July.	1888. Aug.
1. Blue-green Algæ,	0.0	0.0	0.0
2. Other Algæ,	0.2	0.5	0.7
3. Fungi,	0.6	2.0	0.5
4. Animal Forms,	pr.	1.8	0.7

Groups and principal genera of organisms observed: 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ; Zygnemaceæ. 3. Schizomycetes, *Crenothrix*. 4. Protozoa, *Peridinium;* Spongiaria; Nematoda; Rotifera; Entomostraca.

Chemical Examination of Water from Meadow Brook at East Bridgewater.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.	1888.											
2845	July 24	July 26	Slight.	Consid'ble, brown.	1.70	7.75	2.25	5.50	.0046	.0422 .0272	.62	.0190	.0004
3009	Aug. 21	Aug. 22	Distinct.	Consid'ble, rusty.	2.50	6.85	3.00	3.85	.0014	.0578 .0478	.52	.0030	.0002
Av.	....	....	....	....	2.10	7.30	2.63	4.67	.0030	.0500 .0375	.57	.0110	.0003

Odor, vegetable or mouldy.——The samples were collected from the brook, just above its confluence with the Matfield River.

Microscopical Examination.

July, 1888. 1. Blue-green algæ, 1.2; 2. Other algæ, 5.7; 3. Fungi, 2.0; 4. Animal forms, 0.4.

August, 1888. 1. Blue-green algæ, 0.0; 2. Other algæ, 4.9; 3. Fungi, 3.0; 4. Animal forms, 11.2.

Groups and principal genera of organisms observed: 1. Cyanophyceæ, *Oscillaria*. 2. Palmellaceæ; Zoosporeæ, *Scenedesmus;* Desmidiaceæ; Diatomaceæ, *Melosira, Synedra*. 3. Schizomycetes, *Crenothrix*. 4. Protozoa, *Dinobryon, Peridinium, Trachelomonas;* Rotifera; Entomostraca.

Chemical Examination of Water from the Satucket River at East Bridgewater.

[Parts per 100,000]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
2637	June 19	June 20	Very slight.	Very slight.	3.50	6.30	3.55	2.75	.0046	.0376 .0334	.45	.0080	.0001
2846	July 24	July 26	None.	Very slight.	2.50	5.95	2.95	3.00	.0036	.0368 .0320	.50	.0060	.0003
3010	Aug. 21	Aug. 22	Very slight.	Very slight.	1.70	5.50	2.30	3.20	.0034	.0288 .0268	.51	.0050	.0002
Av.	....	....	....	....	2.57	5.92	2.93	2.99	.0039	.0344 .0307	.49	.0063	.0002

Odor, faintly vegetable or mouldy.——The samples were collected from the river below the first bridge above its confluence with the Matfield River.

Microscopical Examination.

	1888. June.	1888. July.	1888. Aug.
1. Blue-green Algæ,	0.0	0.0	0.1
2. Other Algæ,	0.3	0.3	0.4
3. Fungi,	0.1	0.5	0.0
4. Animal Forms,	0.0	pr.	pr.

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Diatomaceæ; Zygnemaceæ. 3. Schizomycetes. 4. Protozoa; Spongiaria; Entomostraca.

Chemical Examination of Water from the Town River at Bridgewater.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
2638	June 19	June 20	Slight.	Slight.	3.20	6.40	3.45	2.95	.0016	.0452 .0400	.37	.0100	.0001
2847	July 24	July 26	Distinct.	Consid'ble.	1.30	9.30	2.20	7.10	.0032	.0392 .0252	.46	.0150	.0003
3011	Aug. 21	Aug. 22	Slight.	Slight.	0.80	4.85	1.70	3.15	.0008	.0254 .0224	.42	.0020	.0004
Av.	....	....	....	....	1.77	6.85	2.45	4.40	.0019	.0366 .0292	.42	.0090	.0003

Odor, faintly vegetable.——The samples were collected from the river at the bridge about half a mile below the wells of the Bridgewaters Water Company, and just above its confluence with the Matfield River.

Microscopical Examination.

	1888.		
	June.	July.	Aug.
1. Blue-green Algæ,	0.0	pr.	0.0
2. Other Algæ,	pr.	0.9	0.2
3. Fungi,	0.3	20.0	0.0
4. Animal Forms,	pr.	pr.	0.1

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ. 3. Schizomycetes, *Crenothrix*. 4. Protozoa; Spongiaria.

Chemical Examination of Water from Winetuxet River at Halifax, just above its Confluence with the Taunton River.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1888.												
2636	June 19	June 20	Slight.	Slight.	3.3	6.70	3.45	3.25	.0026	.0348 .0296	.50	.0080	.0001
2848	July 24	July 26	Very slight.	Consid'ble.	2.3	6.60	2.85	3.75	.0038	.0420 .0368	.46	.0120	.0003
Av.	....	....	....	....	2.8	6.65	3.15	3.50	.0032	.0384 .0332	.48	.0100	.0002

Odor, faintly vegetable.——The samples were collected from the river at the first bridge above its confluence with the Taunton River.

Microscopical Examination.

June, 1888. 1. Blue-green algæ, 0.0; 2. Other algæ, 0.6; 3. Fungi, pr.; 4. Animal forms, 0.1.

July, 1888. 1. Blue-green algæ, pr.; 2. Other algæ, 4.9; 3. Fungi, 0.5; 4. Animal forms, 0.4.

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Desmidiaceæ; Diatomaceæ, *Synedra*. 3. Schizomycetes. 4. Protozoa; Spongiaria.

Chemical Examination of Water from the Nemasket River above Middleborough.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
95	June 14	June 15	Very slight.	Sli't, brown.	0.60	3.47	2.05	1.42	.0005	.0200	.49	.0000	–
308	July 11	July 12	None.	None.	0.70	3.60	1.30	2.30	.0005	.0214	.39	.0000	–
526	Aug. 11	Aug. 12	None.	None.	0.35	3.10	1.30	1.80	.0002	.0170	.48	.0000	–
740	Sept. 12	Sept. 13	Slight.	Slight.	0.20	3.27	1.05	2.22	.0001	.0184	.47	.0000	–
939	Oct. 12	Oct. 13	Very slight.	Very slight.	0.50	3.75	1.10	2.65	.0004	.0205	.51	.0090	–
1145	Nov. 10	Nov. 11	Very slight.	Very slight.	0.10	3.40	1.30	2.10	.0006	.0130	.47	.0030	–
1394	Dec. 13	Dec. 14	Very slight.	Slight.	0.50	4.45	1.70	2.75	.0000	.0210	.52	.0020	–
	1888.												
1669	Jan. 23	Jan. 24	Very slight.	Very slight.	0.20	3.30	1.20	2.10	.0000	.0172	.43	.0050	.0000
1871	Feb. 20	Feb. 21	Very slight.	Very slight.	0.20	3.50	1.40	2.10	.0002	.0189	.49	.0100	.0000
2082	Mar. 21	Mar. 22	Distinct.	Slight.	0.40	3.50	1.45	2.05	.0006	.0211	.45	.0050	.0000
2288	Apr. 23	Apr. 24	Very slight.	Very slight.	0.50	3.10	0.95	2.15	.0004	.0198	.44	.0030	.0001
2473	May 21	May 22	Very slight.	Very slight.	0.50	3.80	1.70	2.10	.0000	.0194	.41	.0050	.0000
2628	June 19	June 20	Very slight.	Very slight.	0.70	3.80	1.60	2.20	.0000	.0226 .0224	.43	.0030	.0001
2840	July 25	July 26	None.	Very slight.	1.10	4.85	2.15	2.70	.0012	.0314 .0270	.41	.0060	.0003
3019	Aug. 22	Aug. 23	Slight.	Slight.	0.80	3.80	1.60	2.20	.0000	.0252 .0226	.34	.0020	.0000
3266	Sept. 26	Sept. 27	Very slight.	Slight.	0.50	3.40	1.50	1.90	.0000	.0184 .0178	.32	.0030	.0002
3435	Oct. 24	Oct. 25	Slight.	Very slight.	0.60	3.45	1.55	1.90	.0002	.0196 .0184	.42	.0030	.0001
3588	Nov. 22	Nov. 23	Very slight.	Slight.	0.70	3.55	1.90	1.65	.0002	.0208 .0168	.42	.0050	.0002
3753	Dec. 19	Dec. 20	Very slight.	Slight.	0.70	3.60	1.50	2.10	.0000	.0178 .0160	.43	.0030	.0002
	1889.												
3914	Jan. 23	Jan. 24	Slight.	Slight.	0.70	3.50	1.55	1.95	.0004	.0186 .0162	.40	.0060	.0002
4156	Feb. 27	Feb. 28	Very slight.	Very slight.	0.70	3.60	1.70	1.90	.0000	.0192 .0164	.44	.0020	.0001
4428	Mar. 28	Mar. 29	Slight.	Slight.	0.70	3.25	1.40	1.85	.0000	.0208 .0172	.42	.0050	.0001
4574	Apr. 25	Apr. 26	Slight.	Slight.	0.80	3.50	1.70	1.80	.0002	.0208 .0192	.41	.0060	.0002
4716	May 22	May 23	Very slight.	Slight.	0.80	3.75	1.75	2.00	.0026	.0258 .0228	.38	.0030	.0002
Av.	....	....	....	....	0.56	3.52	1.38	2.14	.0003	.0204	.43	.0037	.0001

Hardness in May, 1888, 0.8. Odor, distinctly vegetable.—— The samples were collected from the river near the pumping station of the Middleborough Fire District, at a depth of from 1½ to 2½ feet beneath the surface of the water. The water in the river was high on account of heavy rains at the time of collecting samples numbered 1871, 2082, 3019, 3266, 3435 and 3914. This river rises in Assawompsett Pond, 2½ miles from the point where the samples were collected, and consequently has the characteristics of the water of the pond.

Microscopical Examination.

	1888.							1889.				
	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ, ...	pr.	0.0	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	pr.
2. Other Algæ, ...	0.2	0.2	0.2	2.1	pr.	1.1	0.1	0.3	10.3	15.1	4.0	1.4
3. Fungi, ...	0.1	0.6	pr.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, ...	pr.	0.0	0.0	0.0	0.0	0.1	pr.	0.1	0.5	1.4	0.0	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ, *Ulothrix;* Desmidiaceæ; Diatomaceæ, *Asterionella, Synedra, Tabellaria;* Zygnemaceæ. 3. Schizomycetes. 4. Protozoa, *Peridinium;* Spongiaria; Rotifera.

Chemical Examination of Water from the Nemasket River below Middleborough.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
350	July 18	July 19	None.	None.	0.50	3.45	1.10	2.35	.0005	.0193	.43	.0000	–
808	Sept. 18	Sept. 19	None.	Very slight.	0.20	3.70	0.85	2.85	.0003	.0142	.51	.0130	–
982	Oct. 18	Oct. 19	Very slight.	Very slight.	0.30	3.90	1.30	2.60	.0004	.0202	.53	.0030	–
1231	Nov. 21	Nov. 21	Very slight.	Very slight.	0.55	4.20	1.30	2.90	.0008	.0191	.52	.0020	–
1449	Dec. 19	Dec. 21	Very slight.	Very slight.	0.90	4.90	1.60	3.30	.0008	.0214	.59	.0080	–
	1888.												
1657	Jan. 22	Jan. 23	Slight.	Slight.	0.20	3.85	1.70	2.15	.0000	.0201	.43	.0080	–
1866	Feb. 19	Feb. 20	Slight.	Consid'ble.	0.30	3.75	1.15	2.60	.0008	.0230	.50	.0070	.0000
2067	Mar. 20	Mar. 21	Slight.	Consid'ble.	0.60	3.65	1.30	2.35	.0000	.0181	.47	.0070	.0000
2281	Apr. 22	Apr. 23	Very slight.	Slight.	0.60	3.45	1.25	2.20	.0000	.0214	.47	.0100	.0001
2470	May 21	May 21	Slight.	Consid'ble.	0.70	3.90	1.15	2.75	.0004	.0234	.43	.0040	.0000
2641	June 20	June 21	Very slight.	Very slight.	1.00	3.90	1.40	2.50	.0010	.0252 .0198	.43	.0070	.0002
2833	July 25	July 25	Slight.	Sli't, brown.	0.90	4.80	1.80	3.00	.0002	.0298 .0238	.52	.0060	.0000
2986	Aug. 20	Aug. 20	Slight.	Sli't, brown.	0.60	4.40	1.50	2.90	.0006	.0226 .0210	.48	.0030	.0003
3261	Sept. 25	Sept. 26	Very slight.	Very slight.	1.10	4.95	2.25	2.70	.0004	.0282 .0262	.49	.0050	.0002
3430	Oct. 23	Oct. 24	Very slight.	Sli't, rusty, brown.	0.70	3.70	1.25	2.45	.0000	.0200 .0194	.47	.0030	.0002
3598	Nov. 22	Nov. 24	Very slight.	Con., light.	0.80	3.90	1.70	2.20	.0006	.0198 .0176	.46	.0700	.0003
3769	Dec. 19	Dec. 21	Very slight.	Slight.	0.60	3.45	1.30	2.15	.0000	.0210 .0182	.45	.0050	.0002

Chemical Examination of Water from the Nemasket River below Middleborough — Concluded.

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1889.												
3918	Jan. 23	Jan. 24	Slight.	Consid'ble.	0.80	3.50	1.45	2.05	.0004	.0190 .0146	.41	.0060	.0001
4162	Feb. 27	Feb. 28	Very slight.	Slight.	0.65	3.45	1.80	1.65	.0002	.0176 .0150	.46	.0060	.0003
4429	Mar. 28	Mar. 29	Slight.	Con., green.	0.70	3.35	1.30	2.05	.0000	.0208 .0164	.43	.0040	.0001
4579	Apr. 25	Apr. 26	Slight.	Con., green.	0.80	3.70	1.80	1.90	.0000	.0230 .0194	.42	.0030	.0003
4723	May 22	May 23	Very slight.	Consid'ble.	1.10	3.90	1.70	2.20	.0012	.0276 .0258	.44	.0060	.0001
Av.	....	....	....	....	0.62	3.87	1.27	2.60	.0004	.0216	.47	.0055	.0001

Hardness in May, 1888, 0.9. Odor, faintly vegetable. —— The samples were collected from the river at the "Old Mill," just above the confluence of the Nemasket and Taunton rivers.

Microscopical Examination.

	1888.							1889.				
	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ, ...	0.0	pr.	0.0	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	0.3	0.7	pr.	0.2	0.7	1.6	0.9	5.8	25.5	27.2	2.4	1.2
3. Fungi, ...	pr.	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, ...	0.0	pr.	0.0	pr.	pr.	pr.	0.1	0.0	0.8	3.1	pr.	pr.

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diotomaceæ, *Asterionella*, *Synedra*, *Tabellaria;* Zygnemaceæ. 3. Schizomycetes. 4. Protozoa, *Dinobryon;* Spongiaria; Rotifera; Entomostraca.

Chemical Examination of Water from the Taunton River above its Confluence with the Nemasket.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.		Nitrates.	Nitrites.
	1887.												
352	July 18	July 19	Very slight.	Very slight.	1.3	6.55	2.15	4.40	.0016	.0351	.57	.0070	–
809	Sept. 18	Sept. 19	Decided.	Slight.	1.7	7.00	2.10	4.90	.0007	.0342	.69	.0070	–
981	Oct. 18	Oct. 19	Distinct.	Slight.	1.5	6.55	1.60	4.95	.0014	.0306	.72	.0130	–
1232	Nov. 21	Nov. 21	Distinct.	Slight.	1.4	7.50	3.45	4.05	.0021	.0358	.69	.0080	–
1448	Dec. 19	Dec. 21	Decided.	Slight.	1.5	7.45	3.25	4.20	.0036	.0340 .0332	.70	.0120	–
	1888.												
1658	Jan. 22	Jan. 23	Slight.	Very slight.	1.8	7.25	3.15	4.10	.0007	.0284	.51	.0250	.0000
1865	Feb. 19	Feb. 20	Slight.	None.	1.3	6.50	3.00	3.50	.0039	.0294	.60	.0200	.0000
2066	Mar. 20	Mar. 21	Distinct.	Slight.	1.1	4.85	2.10	2.75	.0005	.0230	.50	.0100	.0000
2280	Apr. 22	Apr. 23	Very slight.	Slight.	2.3	5.10	2.45	2.65	.0004	.0312	.51	.0200	.0001
2471	May 21	May 21	Very slight.	Very slight.	2.8	5.85	3.25	2.60	.0016	.0412	.38	.0120	.0001
2640	June 20	June 21	Slight.	Very slight.	–	6.95	3.45	3.50	.0030	.0378 .0360	.53	.0080	.0001
2832	July 25	July 25	Very slight.	Slight.	0.9	4.80	1.45	3.35	.0010	.0214 .0198	.50	.0070	.0001
2987	Aug. 20	Aug. 20	Slight.	Slight.	1.1	6.00	2.00	4.00	.0008	.0276 .0228	.61	.0080	.0003
3262	Sept. 25	Sept. 26	Very slight.	Slight.	2.8	7.90	4.25	3.65	.0008	.0404 .0404	.52	.0100	.0002
3428	Oct. 23	Oct. 24	Very slight.	Slight.	3.7	6.75	3.75	3.00	.0012	.0396 .0370	.57	.0070	.0002
3597	Nov. 22	Nov. 24	Very slight.	Slight.	3.0	6.15	3.35	2.80	.0002	.0342 .0300	.47	.0100	.0004
3770	Dec. 19	Dec. 21	Distinct.	Slight.	0.9	4.00	1.65	2.35	.0000	.0218 .0200	.45	.0080	.0001
	1889.												
3919	Jan. 23	Jan. 24	Slight.	Slight.	1.8	3.95	1.75	2.20	.0002	.0164 .0144	.45	.0050	.0002
4163	Feb. 27	Feb. 28	Very slight.	Very slight.	0.6	4.70	1.90	2.80	.0014	.0208 .0202	.49	.0120	.0003
4430	Mar. 28	Mar. 29	Slight.	Slight.	1.3	4.25	1.45	2.80	.0000	.0238 .0212	.52	.0090	.0002
4580	Apr. 25	Apr. 26	Very slight	Slight.	2.4	5.35	2.70	2.65	.0004	.0374 .0310	.50	.0070	.0001
4724	May 22	May 23	Distinct.	Heavy, brown.	2.8	6.25	3.15	3.10	.0036	.0356 .0350	.49	.0180	.0000
Av.	....	....	....	....	2.2	5.29	2.43	2.85	.0013	.0323	.50	.0113	.0001

Hardness in May, 1888, 1.1. Odor, faintly to distinctly vegetable.—The samples were collected from the river at Woodward's or Sturtevant's bridge about one mile above the confluence of the Taunton and Nemasket rivers.

Microscopical Examination.

	1889.		
	March.	April.	May.
1. Blue-green Algæ,	0.0	0.0	0.0
2. Other Algæ,	0.9	1.4	pr.
3. Fungi,	0.0	0.0	0.0
4. Animal Forms,	0.2	0.0	pr.

Groups and principal genera of organisms observed · 2. Diatomaceæ; Zygnemaceæ. 4. Protozoa; Spongiaria.

Chemical Examination of Water from the Taunton River at Bridgewater, a Short Distance below the Confluence of the Taunton and Nemasket Rivers.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1887.												
92	June 14	June 15	Decided.	Consid'ble.	5.00	6.57	3.27	3.30	.0011	.0414	.58	.0050	–
155	June 21	June 22	Slight.	None.	2.00	6.57	3.27	3.30	.0032	.0320	.42	.0000	–
536	Aug. 12	Aug. 12	Very slight.	None.	1.70	6.50	2.87	3.63	.0023	.0340	.51	.0030	–
810	Sept. 18	Sept. 19	Decided.	Slight.	1.40	5.80	1.85	3.95	.0013	.0241	.60	.0070	–
983	Oct. 18	Oct. 19	Slight.	Very slight.	1.00	5.25	1.15	4.10	.0008	.0216	.65	.0070	–
1230	Nov. 21	Nov. 21	Very slight.	Very slight.	1.10	6.30	2.45	3.85	.0013	.0285	.72	.0100	–
	1888.												
1659	Jan. 22	Jan. 23	Slight.	None.	1.10	6.15	2.20	3.95	.0024	.0242	.47	.0400	.0000
1867	Feb. 19	Feb. 20	Slight.	None.	1.00	5.60	2.00	3.60	.0035	.0271	.56	.0150	.0000
2068	Mar. 20	Mar. 21	Distinct.	Very slight.	1.00	4.45	1.65	2.80	.0004	.0226	.52	.0050	.0000
2282	Apr. 22	Apr. 23	Slight.	Very slight.	1.50	4.25	2.00	2.25	.0004	.0253	.46	.0200	.0002
2469	May 21	May 21	Very slight.	Very slight.	2.50	5.30	2.75	2.55	.0030	.0400	.40	.0080	.0001
2642	June 20	June 21	Very slight.	Very slight.	2.30	5.20	2.55	2.65	.0034	.0248	.46	.0100	.0003
2831	July 25	July 25	Very slight.	Very slight.	1.00	4.75	1.30	3.45	.0008	.0238 .0210	.51	.0150	.0001
2985	Aug. 20	Aug. 20	Slight.	Slight.	0.70	5.50	1.50	4.00	.0014	.0212	.61	.0050	.0003
3263	Sept. 25	Sept. 26	Very slight.	Very slight.	1.70	6.50	3.20	3.30	.0006	.0372 .0352	.51	.0080	.0002
3429	Oct. 23	Oct. 24	Very slight.	Very slight.	2.00	5.80	2.90	2.90	.0014	.0282 .0274	.51	.0050	.0002
3599	Nov. 22	Nov. 24	Very slight.	Slight.	2.40	5.25	2.95	2.30	.0004	.0280 .0276	.46	.0100	.0004

Chemical Examination of Water from the Taunton River at Bridgewater, a Short Distance below the Confluence of the Taunton and Nemasket Rivers — Con.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.	1888.											
3768	Dec. 19	Dec. 21	Slight.	Very slight.	1.00	4.05	1.75	2.30	.0000	.0214 / .0186	.47	.0090	.0002
	1889.	1889.											
3920	Jan. 23	Jan. 24	Very slight.	Very slight.	1.10	3.80	1.60	2.20	.0006	.0168 / .0138	.43	.0070	.0003
4164	Feb. 27	Feb. 28	Very slight.	Very slight.	0.90	4.15	1.75	2.40	.0004	.0192 / .0172	.47	.0090	.0003
4431	Mar. 28	Mar. 29	Very slight.	Very slight.	1.00	4.00	1.70	2.30	.0000	.0200 / .0172	.53	.0070	.0001
4581	Apr. 25	Apr. 26	Very slight.	Very slight.	1.50	4.50	1.95	2.55	.0002	.0264 / .0244	.44	.0050	.0002
4725	May 22	May 23	Very slight.	Slight.	2.40	5.40	2.85	2.55	.0032	.0298 / .0274	.45	.0090	.0001
Av.	....	....	....	....	1.47	5.70	2.31	3.39	.0014	.0268	.51	.0095	.0002

Hardness in May, 1888, 1.1. Odor, faintly vegetable, seldom faintly mouldy.—— The samples were collected from a faucet in the office of the Superintendent of the State Farm.

Microscopical Examination.

	1888. June.	1888. July.	1888. Aug.	1888. Sept.	1888. Oct.	1888. Nov.	1888. Dec.	1889. Jan.	1889. Feb.	1889. Mar.	1889. Apr.	1889. May.
1. Blue-green Algæ, ...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. Other Algæ, ...	0.0	0.6	0.1	pr.	0.0	0.0	pr.	0.1	1.6	3.9	0.8	0.1
3. Fungi, ...	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, ...	0.0	0.2	0.0	0.0	0.0	0.0	pr.	0.0	0.4	0.2	0.0	pr.

Groups and principal genera of organisms observed: 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Asterionella*. 3. Schizomycetes. 4. Protozoa; Spongiaria.

Chemical Examination of Water from the Taunton River at Bridgewater, a Short Distance below the Confluence of the Taunton and Nemasket Rivers.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.		Nitrates.	Nitrites.
	1887.												
93	June 14	June 15	Very slight.	None.	4.00	6.42	2.80	3.62	.0025	.0393	.52	.0050	–
154	June 21	June 22	Very slight.	Slight.	1.80	5.30	2.35	2.95	.0024	.0322	.47	.0260	–
351	July 18	July 19	Very slight.	Very slight.	1.10	4.75	1.40	3.35	.0024	.0251	.48	.0040	–
535	Aug. 11	Aug. 12	Very slight.	Slight.	1.80	6.30	2.75	3.55	.0041	.0357	.44	.0000	–
Av.	....	....	....	....	1.57	5.69	2.33	3.36	.0029	.0331	.48	.0088	–

Odor, faintly vegetable, sometimes faintly mouldy. — The samples were collected from the river at Dunbar's Bridge.

Chemical Examination of Water from the Taunton River at Taunton.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.		Nitrates.	Nitrites.
	1887.												
176	June 22	June 23	None.	Slight.	1.20	4.97	1.85	3.12	.0034	.0322	.48	.0130	–
390	July 22	July 23	Slight.	Very slight.	1.10	5.20	1.55	3.65	.0030	.0265	.48	.0130	–
605	Aug. 23	Aug. 23	Very slight.	Sli't, rusty.	1.30	5.60	1.82	3.78	.0043	.0271	.52	.0070	–
813	Sept. 19	Sept. 20	None.	Slight.	1.50	5.85	1.70	4.15	.0047	.0302	.59	.0070	–
1018	Oct. 24	Oct. 25	Slight.	Sli't, earthy and floc't.	1.00	6.10	1.70	4.40	.0004	.0212	.72	.0080	–
1246	Nov. 21	Nov. 22	Slight.	Slight.	1.40	6.65	3.00	3.65	.0026	.0286	.73	.0100	–
1474	Dec. 22	Dec. 22	Distinct.	Consid'ble.	1.50	6.50	3.00	3.50	.0024	.0334	.58	.0100	–
	1888.												
1673	Jan. 24	Jan. 24	Very slight.	Very slight.	1.00	5.85	2.55	3.30	.0025	.0229	.50	.0200	.0000
1876	Feb. 21	Feb. 23	Decided.	Sli't, earthy and floc't.	0.70	6.35	2.35	4.00	.0020	.0290	.46	.0100	.0000
2088	Mar. 23	Mar. 23	Decided.	Con., e'rthy and floc't.	0.70	5.85	2.25	3.60	.0007	.0318	.44	.0060	.0000
2296	Apr. 24	Apr. 25	Slight.	Slight.	1.40	4.50	1.60	2.90	.0008	.0251	.50	.0090	.0001
2486	May 22	May 22	Very slight.	Slight.	2.50	5.45	2.80	2.65	.0016	.0350	.38	.0080	.0001
2645	June 21	June 22	Very slight.	Slight.	2.30	5.40	2.65	2.75	.0042	.0342 .0306	.45	.0080	.0002
2852	July 26	July 27	Very slight.	Very slight.	1.50	4.95	1.80	3.15	.0030	.0274 .0250	.50	.0050	.0001
3023	Aug. 23	Aug. 24	Slight.	Slight.	1.20	5.45	1.95	3.50	.0010	.0282 .0248	.42	.0030	.0002

Chemical Examination of Water from the Taunton River at Taunton — Concluded.

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1888.												
3279	Sept. 27	Sept. 28	Decided.	Much, e'rthy and floc't.	1.80	5.20	2.60	2.60	.0014	.0420 .0320	.27	.0050	.0002
3453	Oct. 26	Oct. 27	Very slight.	Very slight.	2.30	5.90	3.15	2.75	.0000	.0298 .0286	.53	.0090	.0002
3606	Nov. 26	Nov. 27	Slight.	Con., e'rthy and floc't.	1.80	4.35	2.05	2.30	.0002	0270 .0250	.42	.0100	.0003
3773	Dec. 20	Dec. 21	Distinct, milky.	Sli't, e'rthy.	0.90	3.70	1.55	2.15	.0002	.0200 .0190	.42	.0100	.0002
	1889.												
3922	Jan. 24	Jan. 25	Slight.	Very slight.	1.10	3.85	1.65	2.20	.0000	.0184 .0170	.41	.0070	.0002
4168	Feb. 28	Mar. 1	Very slight.	Very slight.	1.00	4.05	1.75	2.30	.0004	.0194 .0172	.46	.0070	.0001
4432	Mar. 29	Mar. 29	Slight.	Slight.	1.00	4.10	1.90	2.20	.0000	.0200 .0124	.49	.0050	.0002
4593	Apr. 29	Apr. 30	Distinct.	Consid'ble.	2.00	5.00	2.55	2.45	.0008	.0364 .0328	.44	.0060	.0001
4729	May 23	May 24	Very slight.	Slight.	2.70	5.50	3.00	2.50	.0048	.0346 .0308	.43	.0050	.0002
Av.	....	....	....	....	1.45	5.74	2.18	3.56	.0019	.0284	.49	.0084	.0001

Hardness in May, 1888, 1.0. Odor, vegetable, frequently mouldy.——The samples were collected from the river opposite the filter basin of the Taunton Water Works.

Microscopical Examination.

	1888. June.	1888. July.	1888. Aug.	1888. Sept.	1888. Oct.	1888. Nov.	1888. Dec.	1889. Jan.	1889. Feb.	1889. Mar.	1889. Apr.	1889. May.
1. Blue-green Algæ, ...	pr.	0.0	0.0	0.3	pr.	0.0	0.0	0.0	0.0	0.0	0.0	pr.
2. Other Algæ, ...	0.1	1.6	0.6	2.7	0.0	0.2	0.3	0.3	5.6	5.3	0.3	0.3
3. Fungi, ...	0.1	2.5	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms, ...	pr.	pr.	0.2	0.3	0.0	0.0	pr.	0.0	0.2	0.3	pr.	0.0

Groups and principal genera of organisms observed: 1. Cyanophyceæ.* 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Asterionella*, *Synedra*. 3. Schizomycetes, *Crenothrix*. 4. Protozoa; Spongiaria.

Ten Mile River.

This river, although small, was selected for examination because the growing towns of Attleborough and North Attleborough, with a total population in 1885 of 13,175, are situated upon its upper waters, and both take a water supply from wells near it. The river is situated in the southerly part of Massachusetts, just east

of the Rhode Island boundary. It rises in Wrentham and flows in a south-easterly direction to Attleborough, where it turns and flows south-westerly to tide water opposite the city of Providence, R. I. It drains about 51 square miles of rolling country mostly in Massachusetts.

The river above Attleborough has considerable fall, which is utilized for water power; the principal industry being the manufacture of jewelry.

The following table gives statistics of population, etc., at three points in the valley: —

LOCALITY.	Distance above Mouth. Miles.	Drainage Area. Sq. Miles.	Population (1885).	Population per Square Mile.
At outlet of Whiting's Mill Pond, near well of North Attleborough Water Works, ...	17.8	4.3	1,156	269
Opposite well of Attleborough Water Works, . .	12.4	21.1	8,067	382
At second railroad crossing below Attleborough, .	10.4	25.1	10,557	421

Examinations of the river water were made monthly from June, 1887, to May, 1889, opposite the well of the Attleborough Water Works and at the outlet of Whiting's Mill Pond, near the well of the North Attleborough Water Works. A single examination of the river was made at Wrentham, the sample being collected from Witherell's Mill Pond in the village of Plainville. The results of these examinations are given in the following tables. They show but very little, if any, pollution at Plainville and North Attleborough. The pollution at Attleborough is noticeable and sufficient to render water taken directly from the river unfit for drinking.

Chemical Examination of Water from Witherell's Pond, Wrentham.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.		Nitrates.	Nitrites.
	1889.												
4269	Mar. 11	Mar. 11	Very slight.	Slight.	0.1	2.65	0.65	2.00	.0002	.0082 .0074	.27	.0070	.0000

Odor, very faintly vegetable. — The sample was collected from Witherell's Pond in the village of Plainville.

Chemical Examination of Water from the Ten Mile River at North Attleborough.

[Parts per 100,000.]

	Date of		Appearance.			Residue on Evaporation.			Ammonia.			Nitrogen as	
Number.	Collection.	Exam-ination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.	Chlorine.	Nitrates.	Nitrites.
	1887.												
943	Oct. 13	Oct. 13	Distinct.	Sli't, white.	0.30	3.65	0.55	3.10	.0000	.0219	.36	.0000	-
1399	Dec. 14	Dec. 14	Slight.	Very slight, white.	0.10	3.85	0.85	3.00	.0020	.0130	.40	.0150	-
	1888.												
1598	Jan. 16	Jan. 17	None.	Very slight.	0.20	3.75	0.75	3.00	.0028	.0089	.26	.0250	.0001
1790	Feb. 10	Feb. 10	Slight.	None.	0.10	2.90	0.90	2.00	.0045	.0174	.19	.0150	.0000
2002	Mar. 14	Mar. 15	Slight.	Very slight.	0.05	2.65	0.35	2.30	.0014	.0100	.32	.0100	.0001
2225	Apr. 16	Apr. 17	Slight.	Very slight.	0.20	2.85	0.65	2.20	.0003	.0112	.29	.0080	.0001
2414	May 14	May 15	Distinct.	Very slight.	0.25	3.50	0.95	2.55	.0004	.0256	.30	.0050	.0002
2587	June 12	June 13	Distinct.	Con., white.	0.15	3.78	0.95	2.83	.0000	.0242 .0170	.31	.0070	.0003
2767	July 12	July 13	Very slight.	Sli't, brown.	0.10	3.30	1.05	2.25	.0004	.0186 .0148	.31	.0000	.0000
2919	Aug. 13	Aug. 14	Slight.	Sli't, brown.	0.10	3.50	1.00	2.50	.0012	.0124 .0114	.35	.0030	.0001
3148	Sept. 10	Sept. 11	Slight.	Very slight.	0.15	2.95	0.70	2.25	.0016	.0136 .0114	.27	.0050	.0002
3321	Oct. 8	Oct. 9	Distinct.	Sli't, white.	0.10	3.55	1.10	2.45	.0002	.0134 .0114	.30	.0120	.0002
3523	Nov. 12	Nov. 12	Distinct.	Slight.	0.20	3.30	0.80	2.50	.0000	.0110 .0082	.32	.0150	.0000
3728	Dec. 17	Dec. 17	Very slight.	Very slight.	0.15	3.15	0.90	2.25	.0008	.0080 .0078	-	.0180	.0002
	1889.												
3843	Jan. 14	Jan. 14	Very slight.	Very slight.	0.10	2.65	0.60	2.05	.0004	.0050 .0042	.29	.0150	.0002
4017	Feb. 14	Feb. 14	Very slight.	None.	0.10	2.70	0.50	2.20	.0018	.0070 .0052	.32	.0120	.0000
4317	Mar. 15	Mar. 16	Slight.	Very slight.	0.10	2.65	0.70	1.95	.0000	.0102 .0086	.27	.0100	.0002
4502	Apr. 12	Apr. 12	Distinct.	Slight.	0.10	2.75	0.75	2.00	.0010	.0144 .0092	.27	.0040	.0003
4676	May 16	May 17	Slight.	Slight.	0.10	3.15	0.80	2.35	.0000	.0180 .0160	.27	.0030	.0000
Av.	....	....	....	....	0.14	3.31	0.71	2.60	.0010	.0139	.30	.0096	.0001

Hardness in May, 1888, 1.7. Odor, distinctly vegetable, seldom mouldy.—The samples were collected from Whiting's Mill Pond, at the dam near the well of the North Attleborough Water Works.

Microscopical Examination.

	1888.							1889.				
	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1. Blue-green Algæ, ...	0.0	pr.	0.0	pr.	0.0	0.0	0.0	0.0	0.0	0.0	pr.	0.0
2. Other Algæ, ...	2.0	2.0	0.6	1.0	pr.	0.1	pr.	0.1	0.6	0.9	0.2	0.1
3. Fungi, ...	0.0	0.2	pr.	0.5	0.0	0.0	0.0	0.0	pr.	0.0	0.0	0.0
4. Animal Forms, ...	0.3	0.0	pr.	0.4	0.0	0.0	pr.	0.2	0.0	pr.	0.3	0.3

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Synedra*. 3. Schizomycetes. 4. Protozoa; Rotifera; Entomostraca.

Chemical Examination of Water from the Ten Mile River at Attleborough.

[Parts per 100,000.]

Number.	Date of		Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Collection.	Examination.	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.		Nitrates.	Nitrites.
	1887.												
133	June 17	June 18	Very slight.	None.	0.60	5.02	1.80	3.22	.0004	.0180	.36	.0130	–
357	July 18	July 19	Very slight.	Very slight.	0.80	4.05	1.60	2.45	.0038	.0297	.31	.0030	–
550	Aug. 16	Aug. 16	Slight.	None.	0.60	4.92	1.35	3.57	.0004	.0188	.41	.0030	–
775	Sept. 15	Sept. 16	Distinct.	Consid'ble.	0.30	4.65	1.40	3.25	.0016	.0234	.45	.0030	–
1016	Oct. 24	Oct. 25	Distinct.	Sli't, e'rthy.	1.00	5.95	2.10	3.85	.0006	.0273	.57	.0100	–
1357	Dec. 8	Dec. 9	Distinct.	Slight.	0.35	5.10	1.45	3.65	.0046	.0164	.58	.0280	–
	1888.												
1785	Feb. 9	Feb 10	Slight.	Slight.	0.50	4.75	1.65	3.10	.0131	.0192	.38	.0280	.0002
2208	Apr. 13	Apr. 14	Very slight.	Very slight.	1.10	4.00	1.30	2.70	.0000	.0227	.31	.0120	.0002
2591	June 12	June 13	Very slight.	Sli't, white.	0.50	4.30	1.35	2.95	.0004	.0246 .0208	.25	.0100	.0002
2722	July 6	July 6	Very slight.	Very slight.	1.50	4.85	2.35	2.50	.0002	.0280	.34	.0080	.0002
3094	Sept. 6	Sept. 7	Very slight.	Slight.	0.35	4.80	1.65	3.15	.0024	.0262 .0238	.40	.0030	.0000
3445	Oct. 25	Oct. 26	Very slight.	Very slight.	0.70	4.50	1.65	2.85	.0000	.0214 .0172	.42	.0180	.0005
3624	Nov. 30	Dec. 1	Slight.	Con., e'rthy.	0.45	3.60	1.50	2.10	.0006	.0154 .0154	.34	.0200	.0002
3762	Dec. 20	Dec. 20	Distinct.	Sli't, earthy and floc't.	0.50	3.45	1.10	2.35	.0024	.0154 .0130	.30	.0180	.0004
	1889.												
4022	Feb. 15	Feb. 15	Sli't, milky.	Slight.	0.30	3.75	1.20	2.55	.0070	.0080 .0066	.40	.0250	.0003
Av.	....	....	....	....	0.64	4.81	1.58	3.23	.0025	.0210	.39	.0135	.0002

Hardness in December, 1887, 2.0. Odor, generally vegetable, sometimes mouldy. — The samples were collected from the river opposite the collecting well of the Attleborough Fire District. At the time No. 3624 was collected the river was very high on account of heavy rains.

Microscopical Examination.

	1888.						1889.
	June.	July.	Sept.	Oct.	Nov.	Dec.	Feb.
1. Blue-green Algæ,	0.0	0.0	0.0	0.0	pr.	0.0	0.0
2. Other Algæ,	8.4	1.0	1.1	8.1	2.1	0.0	1.5
3. Fungi,	pr.	2.0	0.0	0.0	0.0	0.0	0.0
4. Animal Forms,	0.4	pr.	0.2	0.0	0.0	0.0	1.2

Groups and principal genera of organisms observed: 1. Cyanophyceæ. 2. Palmellaceæ; Zoosporeæ; Desmidiaceæ; Diatomaceæ, *Asterionella, Synedra, Tabellaria;* Zygnemaceæ. 3. Schizomycetes, *Crenothrix.* 4. Protozoa, *Dinobryon.*

Westfield River.

The Westfield River, one of the principal affluents of the Connecticut River from the west, rises among the Berkshire Hills in the north-eastern part of Berkshire County and flows thence in a southerly and south-easterly direction to the Connecticut River, opposite the southerly portion of the city of Springfield, draining an area of 515 square miles, all of which is within the State of Massachusetts.

The upper portion of the drainage area, down to within five miles of the town of Westfield, or sixteen miles of the mouth of the river, is mountainous, and throughout this area the larger streams flow through narrow valleys, the precipitous slopes of the mountains in many places rising directly from the water. The mountains are generally covered with a growth of wood, though in many places they are barren and rocky. The fall of the main river and its tributaries in this region is very rapid.

In the lower sixteen miles of its course, the river flows through a region which is comparatively flat except about three miles east of Westfield, where it is crossed from north to south by a high ridge. The fall of the stream from the top of the dam at Westfield to the mouth of the river, a distance of eleven miles, is ninety-four feet.

There are several reservoirs and a few ponds on the watershed, but the total amount of water stored is comparatively small, and, owing to this and the mountainous character of the area drained, the flow of the river is subject to great fluctuations.

Westfield (population in 1885, 8,961) is the only large town in the basin. It has a public water supply and has recently adopted

and partly built a system of sewerage with an outfall into the main river below the town and just above the mouth of Little River.

The towns on the river above Westfield are small, the largest having a population of but 1,318 in 1885, and none of them have a public water supply or system of sewerage. West Springfield, the largest town below Westfield, had in 1885 a population of 4,448; but most of it drains towards the Connecticut River.

The following table gives statistics of drainage area, population, etc., above three points on the Westfield River.

LOCALITY.	Distance above Mouth of River. Miles.	Drainage Area. Sq. Miles.	Population (1885).	Population per Square Mile.
Just above Little River at Westfield,	10.2	367.0	15,761	43
Just below Little River at Westfield,	10.2	452.4	19,338	43
At mouth,	0.0	515.0	23,073	45

The Westfield River basin was examined by the State Board of Health in 1879, and the results of this examination were published in the supplementary report of the board for that year, pp. 3–13.

The following table, showing a summary of the manufacturing establishments in the valley, is taken from page 12 of the report: —

MANUFACTURES.	Number.	Operatives employed.
Paper Mills,	12	639
Tanneries,	2	41
Cloth Mills,	2	75
Dress Goods,	1	120
Cotton Mill,	1	255
Totals,	18	1,130

Analyses of the water of the Westfield River have not been made regularly because it was polluted so little during the time covered by these investigations that it seemed unnecessary. A single analysis was made, however, in connection with an examination of the ice

supplies of the State, and is given below. The discharge of the sewage of Westfield into the river will render the water unfit for drinking at points below : —

Chemical Examination of Water from the Westfield River at Agawam.

[Parts per 100,000.]

Number.	Date of Collection.	Date of Examination.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Residue on Evaporation. Fixed.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.
	1889.												
4228	Mar. 6	Mar. 7	Distinct, milky.	Con.,e'rthy.	0.1	3.65	1.15	2.50	.0028	.0128 .0080	.15	.0100	.0002

Odor, faintly mouldy. —— The sample was collected from the river, opposite the ice-house of A. P. Lord, about half a mile from the mouth of the river.

The Chemical Examination of Waters

AND

THE INTERPRETATION OF ANALYSES.

By THOMAS M. DROWN, M.D.,

CHEMIST OF THE BOARD.

THE CHEMICAL EXAMINATION OF WATERS.

The chemical examination of the waters of the State have been made in the laboratories of the Massachusetts Institute of Technology. In this work I have had, at different times during the two years covered by this report, as assistants, Messrs. Henry P. Talbot, Arthur A. Noyes, Frederick Fox, Jr., Herbert A. Richardson, Henry Martin, Augustus H. Gill, Daniel F. Gay, L. Kimball Russell, Russell H. Colby, George L. Heath, Harry S. Mulliken and Misses Clara P. Ames, Isabel F. Hyams, Sarah L. Day and Adelaide Sherman. I desire to express my obligations to all of them for careful and thoughtful work.

Associated with me in the direction of the chemical work, during the entire time, has been Mrs. R. H. Richards. The long laboratory experience which Mrs. Richards had had, in connection with Professor William Ripley Nichols's admirable work for the State, had given her such an intimate knowledge of modern methods of water analysis that she was pre-eminently fitted for assuming the immediate charge of the laboratory. The accuracy of the work and the no less important accuracy of the records are mainly due to her great zeal and vigilance.

In order that the results of the chemical examination of waters shall have any value, it is of the utmost importance that scrupulous care should be exercised in the collection of the samples. The bottles used by us for this purpose are of one gallon capacity, made of heavy white glass in wooden moulds. They are fifteen inches high to the top of the stopper, five and a half inches in diameter, and weigh a little over three pounds. They have flat mushroom stoppers without necks. Each bottle is engraved "State Board of Health," with a number, which is duplicated on the stopper. These

bottles are carefully cleaned with sulphuric acid and potassium bi-chromate, thoroughly washed with distilled water and then dried. They are sent out from the laboratory in uncovered wooden boxes lined with packing paper. The stoppers are secured by a piece of brown paper tied over them. The exposure of the top of the bottle ensures the upright position of the bottle when transported by express; breakage from this exposure is very rare. In winter a box with felt packing is used. To each bottle is tied an envelope tag, on which is written the address of the person who is to collect the sample of water and the date when it is to be taken. In this envelope are printed directions for taking the sample, a square of clean cotton cloth to tie over the stopper, and pieces of twine and sealing wax. There is also a blank certificate to be filled out, giving particulars of the water collected, and an envelope tag, addressed to the laboratory in Boston, into which the certificate is placed. When the sample is taken this tag is tied to the bottle, which is replaced in its box, and the water is then ready to ship by express.

Following are copies of the directions for collecting the samples and of the certificate: —

STATE BOARD OF HEALTH OF MASSACHUSETTS.

Instructions for Collecting Samples of Water for Analysis.

1st. From a Water Tap. The water should run freely from the tap for a few minutes before it is collected. The bottle is then to be placed directly under the tap, and rinsed out with water three times, pouring out the water completely each time. It is then again to be placed under the tap, filled to overflowing, and a small quantity poured out, so that there shall be left an air-space under the stopper of about an inch. The stopper must be rinsed off with flowing water, and inserted into the bottle while still wet, and secured by tying over it a clean piece of cotton cloth. The ends of string must be sealed on the top of the stopper. Under no circumstances must the inside of the neck of the bottle or the stem of the stopper be touched by the hand or wiped with a cloth.

2d. From a Stream, Pond or Reservoir. The bottle and stopper should be rinsed with the water, if this can be done without stirring up the sediment on the bottom. The bottle, with the stopper in place, should then be entirely submerged in the water and the stopper taken out at a distance of twelve inches or more below the surface. When the bottle is full, the stopper is replaced below the surface, if possible, and finally secured as above. It will be found convenient in taking samples in this way to have the bottle weighted, so that it will sink below the surface. It is important that the sample should be obtained free from the sediment on the bottom of a stream and from the scum on the surface. If a stream should not be deep enough to admit of this method of taking a sample,

the water must be dipped up with an absolutely clean vessel and poured into the bottle after it has been rinsed.

The sample of water should be collected immediately before shipping by express, so that as little time as possible shall intervene between the collection of the sample and its examination.

The accompanying "certificate" must be filled out carefully and enclosed in the envelope shipping tag.

CERTIFICATE

Accompanying a Sample of Water, to be enclosed in the envelope tag addressed to the State Board of Health, Boston.

SAMPLE OF WATER.

From ____

Name of city or town.

Collected and sealed by ____

Name and address of collector.

____

Collected from ____

State whether the water is from a tap or from stream, pond, reservoir or other source.

____

____

Collected on ____

Give day, date and hour of day.

____

Shipped by ____________________ *Express* ____________________

____

Give date and hour of day.

REMARKS. — In case there are any abnormal or unusual conditions existing in the source of the water, mention the facts: as, for instance, if the streams or ponds are swollen by recent heavy rains; or are unusually low in consequence of prolonged drought; or if there is a great deal of vegetable growth in or on the surface of the water. Write on the other side of this certificate.

The collection of samples throughout the State is so arranged that a certain number of samples shall arrive at the laboratory each day, and also that the time shall not exceed twenty-four hours between the collection of the water and its receipt at the laboratory.

The regular examination of the waters has consisted in the determination of the turbidity, sediment, color, odor (cold and hot), residue on evaporation, loss on ignition, change on ignition, free ammonia, albuminoid ammonia, nitrogen as nitrates and nitrites, and chlorine. Occasionally determinations have been made of the total organic nitrogen, dissolved oxygen, oxygen absorbed from permanganate, hardness and the alkalinity.

In the tabulated results of the analyses given in the foregoing pages will be found the turbidity and sediment, color, the residue on evaporation and the loss on ignition (except in the case of ground waters), the chlorine, and the nitrogen in four forms, namely, free ammonia, albuminoid ammonia, nitrates and nitrites. The hardness and the general character of the odors of the waters are given in a foot-note.

METHODS OF ANALYSIS.*

When a bottle of water is received at the laboratory, the certificate is taken out of the envelope tag and a serial number is put both on the tag (which remains attached to the bottle) and on the certificate. A copy of the certificate is entered in a book of record with the time (date and hour) when the water was received. The analysis of the water is made under this serial number. Separate blank forms, bound in books, are provided for the various determinations: thus, there is a book for "general characters," which include turbidity, sediment, color and odor; another for free and albuminoid ammonia; another for chlorine, and so on. These results are collected and entered in other books in tabulated form, first under the serial number and again under the localities from which the waters came. An index volume facilitates reference to all the records.

The determination of the nitrogen is begun without delay. As soon as the sample has received its number, the seal is broken and the cloth removed. The top of the bottle is now placed under a tap of running water, and the stopper and neck well washed from any adhering dirt or dust. The contents of the bottle are then thoroughly mixed by shaking, and 500 c.c. poured out into a

* In the laboratory of the Sewage Experiment Station at Lawrence the chemical methods in use are in some cases modified to adapt them to the special character of work at the Station. Some of these methods are very fully described in the second volume of this report (which contains an account of the experiments on the filtration of sewage), and reference is frequently made to them in this connection to avoid repetition.

graduated flask (after rinsing with the same water) for the determination of the free and the albuminoid ammonia. In the case of surface waters, and all waters which are not perfectly clear, a portion, about 900 c.c., is next filtered through a large plaited filter of Swedish paper which has been previously thoroughly washed with water free from ammonia. Of this filtered water 500 c.c. are used for albuminoid ammonia, and smaller portions for the determination of the dissolved solids and color. Portions of the original sample are also taken out promptly for the determination of the nitrites and nitrates. The bottle with the residue of the original sample is now put on a table which is covered with a white cloth or paper, before a window. Here it stands over night and the next morning it is inspected for the turbidity and sediment. After this inspection a portion is taken for the determination of the chlorine, hardness, etc.

It is important that the odor and the amount and condition of the nitrogen should be determined as soon as possible after the sample is received, since the nitrogen compounds are in some waters liable to change, and it is largely upon the condition in which the nitrogen exists in the water that our opinion of the sanitary quality is based. If a sample of water is received at the laboratory too late in the day for examination, it is put in an ice-chest over night to hinder or retard change. In the determination of the mineral contents of the water the delay of a day or two is not of much consequence.

Determination of the Free and Albuminoid Ammonia.

The apparatus for the determination of the ammonia consists of a round-bottomed flask of a capacity of 900 c.c., with a neck five inches long, and an ordinary glass condenser. The interior glass tube is three-eighths of an inch internal diameter, and is in contact with the condensing water for one foot ten inches. The flask is closed by a cork carrying a glass tube, bent nearly at right angles, which slips for about four inches within the condensing tube. A tight joint is easily and quickly made by means of a large cork, about one and one-fourth inches in diameter, permanently and tightly fitted on the bent tube, with a depression cut into one end, into which the end of the condensing tube fits. This large cork serves the double purpose of making a tight joint with the condenser and also as a convenient means of handling the small glass tube. When the cork

of the distilling flask is to be removed the tube is not disconnected from the condenser, but it is simply turned (together with the cork of the flask) to one side.

New flasks are treated with boiling dilute sulphuric acid and potassium bi-chromate before they are put to regular use. New corks give off ammonia in contact with the steam from the boiling water, and must be treated, in position, under these conditions for two or three hours before they are ammonia-free. A good sound cork will last for two or three months with continuous daily use. The flasks are placed on wire rings and heated with the free flame of a Bunsen burner.

Five hundred cubic centimeters of water are poured into the flask when the apparatus has been proved to be ammonia-free, and boiled until three portions of 50 c.c. each have been distilled over. No soda is added to surface waters in the determination of the free ammonia except in special cases when, like water from the Blackstone River for instance, the sample is likely to be acid. Almost all the natural waters have a slightly alkaline reaction, and experiment has shown the use of soda to be unnecessary.

Alkaline permanganate free from ammonia is added to the contents of the flask after the collection of 150 c.c. of distillate. Usually 40 c.c. are added. Very brown waters may require as much as 50 c.c. It is added cautiously to the flask (waiting a minute or two until the contents have cooled slightly) by means of a funnel, so that none comes in contact with the neck of the flask. The boiling is now continued at such a rate that it shall require about eight minutes to collect 50 c.c.

In the case of brown surface waters the amount of albuminoid ammonia varies considerably according to the manner of conducting the operation. Thus a long protracted boiling will give a higher result in the same amount of distillate than a shorter treatment. To obtain all the albuminoid ammonia that such waters are capable of giving would involve an almost interminable operation. It is of more importance to have constant conditions so that the results obtained on different waters shall be comparable. Five portions of 50 c.c. each are collected for the albuminoid ammonia. In waters of low organic contents four portions will suffice.

The Nessler tubes are 12 inches long and $\frac{5}{8}$ inch internal diameter, the 50 c.c. mark being about two inches below the top. The distillates are not nesslerized until the operator is ready to determine the

ammonia. The usual practice is to nesslerize 200 or more distillates and the standards at the same time.

Standards for reading the colors for nesslerization are made, containing the following amounts of the standard ammonium chloride solution, namely, 0.1, 0.2, 0.3, 0.4, 0.5, 0.7, 0.9, 1.0, 1.3, 1.5, 1.8, 2.0, 2.3, 2.5, 2.8, 3.0, 3.5 and 4.0 c.c. All the members of this series are made at one time; should any error be made in any one of the standards it would be easily detected in the irregularity of the depth of color.

As far as possible the results of each day's work are read at one time with one set of standards, which should not, however, be used after three hours from the time they are prepared. They sometimes fade before this time, a fact which will be recognized by an experienced eye. The permanency of color produced by nesslerization depends somewhat upon the sensitiveness of the reagent; the more quickly the color is produced, the less its permanence. This fact must be borne in mind in making the Nessler solution, and each time a quantity is prepared it must be compared with that in use to see that it agrees in depth of color produced and in sensitiveness. For the measurement of quantities above 4 c.c. of the standard ammonium chloride solution it is often convenient to use a pair of Hehner's colorimeters, matching the colors by running off a known portion of the solution having the deeper color. In using this method it is important to use a standard not differing much from the distillate to be tested, since the depth of color produced by nesslerization is not directly proportional to the amount of ammonia. For instance, the depth of color produced by nesslerizing 10 c.c. of ammonia solution is more than twice that of 5 c.c. in the same bulk (say 100 c.c.) of water, and a reduction of the height of the column of liquid to one-half of the stronger solution will not reduce the depth of color to that produced by 5 c.c. of the ammonia solution.

The importance of having uniformity of temperature of the solutions to be tested and the standards, is essential. In winter time, when the temperature of the distillates is much below the temperature of the room, a considerable time must elapse before equality of temperature is reached. On this account, and owing to the shortness of the winter days, it is well to let the distillates remain in the tubes over night, protected from dust, before nesslerization. If an immediate reading is required, it is necessary to bring distil-

lates and standards to the same temperature or else make a correction for the deeper color produced in the warmer solution.*

Determination of the Organic Nitrogen.

There can be no doubt that the determination of the total organic nitrogen would be generally practised in place of the determination of the albuminoid ammonia, if there was available a short, easily-executed, and accurate method for this purpose. As the result of a very large number of experiments with the Kjeldahl nitrogen process, we think it may be safely said, that this method leaves little, if anything, to be desired in these respects. The method employed is as follows: —

Five hundred c.c. of the water are poured into a round-bottomed flask, of about 900 c.c. capacity, and boiled until 200 c.c. have been distilled off. The free ammonia which is thus expelled may, if desired, be determined by connecting the flask with a condenser. To the remaining water in the flask is added, after cooling, 10 c.c. of pure concentrated sulphuric acid.† After shaking, the flask is placed in an inclined position on wire gauze, on a ring-stand or other convenient support, and boiled cautiously, in a good drawing hood, until all the water is driven off and the concentrated sulphuric acid is white or a very pale yellow. After cooling, 200 c.c. of water free from ammonia are added, the neck of the flask being washed free from acid, and then 100 c.c. of sodium hydrate‡ solution. The flask is immediately connected with the condenser and then shaken to mix the contents.

The distillation at the start is conducted rather slowly. After the first 50 c.c. are condensed, the contents of the flask may be boiled more rapidly until 150 c.c. to 175 c.c. have altogether been collected. The total distillate is made up to 250 c.c. with water free from ammonia, well mixed, and 50 c.c. taken for nesslerization.

* Compare "Methods of Analysis" at the Lawrence Experiment Station in the second volume of this report; also paper on "The Effect of Temperature on the Determination of Ammonia by Nesslerization," by Allen Hazen and Harry W. Clark, in Am. Chem. Jour., vol. 12, No. 6.

† It is necessary to have for this purpose sulphuric acid which is very nearly, if not quite, free from nitrogen in any form. Baker & Adamson, of Easton, Penn., make an acid for this purpose which contains only .005 milligram of ammonia in 10 c.c.

‡ The sodium hydrate solution is made by dissolving 200 grams of caustic soda, free from chlorine, in 1.25 litres of distilled water, adding two grams of potassium permanganate and boiling down to somewhat less than a litre. When cold, the solution is made up to a litre. The addition of the permanganate is to oxidize any organic matter which may be present in the caustic soda.

Since the greater part of the ammonia comes over in the first portion of the distillate, it is well to have a little dilute hydrochloric acid in the condensing flask.*

In carrying out the operation, the most scrupulous care must be observed in preventing access of ammonia from any source. The acid solutions will absorb ammonia from the air of the laboratory or from the dust of the room if they are allowed to remain uncovered for any length of time. This source of error has been found at times to be very large; quite enough to render a determination valueless. One experiment gave a gain of ammonia in twenty hours, by leaving the flask which contained the concentrated sulphuric acid uncovered, equivalent to 0.5 c.c. of the standard ammonium chloride solution, and at another time the gain was 3 c.c. This was in a room from which ammonium hydrate is carefully excluded.

The operation should, therefore, be carried out without interruption, in a place free from dust, and for every determination, or set of determinations, a blank analysis with ammonia-free water should be made for a correction for the ammonia in the reagents and that accidentally introduced in the process.

We have not found that the presence of nitrates and nitrites in waters interferes with the accurate determination of the organic nitrogen. The error which has been found by Kjeldahl and Warrington to be caused by nitrates in the determination of organic nitrogen seems to disappear under the conditions of great dilution which we have in natural waters.

As the result of many hundred comparative determinations of organic nitrogen and albuminoid ammonia in natural waters, we have found that the total nitrogen is about twice the nitrogen of the albuminoid ammonia, as we determine it.†

Determination of the Nitrogen as Nitrites.

Warrington's modification of the Griess method is used for the determination of the nitrites.‡ The process consists in adding to the water to be tested two or three drops of hydrochloric acid (strong

* This acid should be free from ammonia: one c.c. of the acid is equivalent to 0.5 milligram of ammonia.

† See paper on "The Determination of Organic Nitrogen in Natural Waters by the Kjeldahl Method," by Thomas M. Drown and Henry Martin. Technology Quarterly, February, 1889; Chemical News, vol. 59, p. 272.

‡ Berichte d. deut. chem. gesellsch XI. 624; Jour. Chem. Soc., 1881, p. 231.

acid with an equal bulk of water), then 2 c.c. of a saturated solution of sulphanilic acid and finally 2 c.c. of a saturated solution of naphthylamine hydrochlorate (8 c.c. naphthylamine, 8 c.c. strong hydrochloric acid and 992 c.c. of water). The pink color produced when nitrites are present is compared with the depth of color obtained from known amounts of a standard sodium nitrite solution under the same conditions. The comparison of colors is conveniently made in 100 c.c. tubes. A depth of color above that produced by a water containing 0.0020 parts of nitrogen as nitrite is too great to be read accurately. Waters containing more than this amount should be diluted with a known amount of distilled water free from nitrites, or compared by means of colorimeters, using the same precaution as in the case of the determination of ammonia by this means.

Surface waters having a color above 0.1 must be decolorized by shaking with aluminum hydrate and rapidly filtered or decanted into the tubes before testing for nitrites. Since the air of rooms in which gas is burned always contains nitrites, it is important that there should not be any unnecessary exposure of the waters that will give opportunity for the absorption of nitrous acid.

The comparison of the colors with the standards is made in twenty minutes to an hour after the reagents are added.

Determination of the Nitrogen as Nitrates.

The Phenolsulphonic process of Grandval and Lajoux * has been used for all the determinations of nitrates in natural waters. This process has been carefully studied in the laboratory of the Lawrence Experiment Station, as well as in the laboratory of the Board at the Institute of Technology, and the reader is referred to the second volume of this report for a full description of the nature of the process and the conditions of its successful use.

Determination of the Chlorine.

The method for the determination is that in general use ; namely, titration with a solution of silver nitrate, using potassium chromate as an indicator. Most of the natural waters of the State contain so little chlorine that a direct titration gives uncertain results. All waters (except those known to be high in chlorine) are concentrated in porcelain dishes on a steam bath, care being taken not to let the

* Comptes Rendus. July 6, 1885.

contents go to dryness. Usually 250 c.c. are evaporated to 25 c.c. and the titration made in the same dish. To guard against loss of chlorine in the evaporation, a small quantity, say 20 milligrams, of sodium carbonate may be added to the water; this amount does not interfere with the accuracy of the titration. Before the titration is made, the sides of the dish above the liquid must be washed down with distilled water free from chlorine, and rubbed with a feather or rubber; washing alone will not dissolve all the chlorides which adhere to the sides of the dish. When the amount of chlorine is very low, a known amount of salt added to the liquid facilitates the titration by making more definite the determination of the end point.

Brown surface waters must be decolorized before titration. This is conveniently done by adding a small amount of aluminum hydrate to the water, or by adding a solution of alum and then sodium carbonate, filtering off the precipitate, or decanting the clear fluid after the alumina has settled. If the water is brought nearly to boiling with the alumina, the latter will settle more promptly.

The volume of liquid in which the chlorine is determined has an effect on the amount of silver solution used in the titration — the larger the volume, the greater the amount of silver used for the same amount of chlorine present. This has been studied by Mr. Allen Hazen of the Lawrence Experiment Station, and the reader is referred for a statement of his results to the second volume of this report.*

The Determination of the Residue of Evaporation and Loss on Ignition.

The evaporation to dryness on a water bath of a known volume of water in a weighed platinum dish, and subsequently heating the dish to a temperature of 100° C. in an air bath, gives the total weight of the organic and inorganic matter contained in the water. On igniting this residue the organic matter is burned off and the residue consists of the "fixed solids."

This "loss on ignition" was, before the introduction of modern methods of water analysis, the only method of determining the organic matter in water. Since it has been shown that this loss on ignition, as ordinarily obtained, is valueless as a determination of

* See also paper on "The Determination of Chlorine in Water," by Allen Hazen, Am. Chem. Jour., Vol. XI., p. 409.

the organic matter it has fallen largely into disuse in water analysis. It is, however, possible by carefully regulating the heat in the ignition to destroy the organic matter without decomposing calcium carbonate or volatilizing the alkaline chlorides. This is accomplished by heating the dish containing the residue of evaporation by radiation from another and larger platinum dish, within which it is placed.*

In the case of surface waters, with low mineral contents and considerable organic matter, this method has been used with satisfactory results. In the case of ground waters, with little or no organic matter and high mineral contents, the loss on ignition even with this carefully regulated temperature, bears no relation whatever to organic matter. The loss under these conditions is often very great, resulting from the decomposition of nitrates and chlorides of the alkaline earths and the loss of water of crystallization. The determination of the loss on ignition under these conditions is meaningless, and it has not been included in the foregoing tabulation of results.

By the addition of sodium carbonate to the solution before evaporation to dryness, the alkaline earths are precipitated as carbonates and the chlorine and nitric acid are supplied with an alkaline base; there is also, under these conditions, no water of crystallization present in the residue. The loss on ignition under these conditions will give an approximate determination of the organic matter when present in appreciable quantity. This procedure is in regular use at the Lawrence Experiment Station for the determination of the fixed solids and loss on ignition in the sewage and effluents from the filtration of sewage, and the reader is referred to the second volume of the report for the results of extended investigations into the behavior of various salts of the alkalies and alkaline earths under these conditions.

Since this method gives the actual amount of mineral matter present in the water in the anhydrous condition, it might be thought desirable to employ it in all cases, both in surface and in ground waters, without regard to the loss on ignition. It has seemed best, however, in the analyses of the natural waters of the State, to adhere to the universal practice of water analysts in obtaining the "total solids;" namely, to evaporate the water to dryness

* See paper on "The Loss on Ignition in Water Analysis," by T. M. Drown. Tech. Quart., December, 1888; Chem. News, vol. 59, p. 272.

without the addition of sodium carbonate, so that the results shall be comparable with those obtained by other chemists.

Determination of the Hardness.

The hardness of the waters has been determined, during the time covered by this report, by the soap method of Dr. Clark, as given in Sutton's Volumetric Analysis, 5th edition, page 363. The results are expressed in terms of an equivalent amount of carbonate of lime in parts per 100,000.

Determination of the Odor.

The odor of the waters is obtained by shaking violently the water in one of the large collecting bottles when it is about one-half full, then removing the stopper and quickly putting the nose to the mouth of the bottle. An odor can often be detected in this way which would be entirely inappreciable if the water were poured into a tumbler. The odor which is given off when a water is heated is sometimes the same as the odor of the water when cold, sometimes it is different. Our practice in getting the hot odor is to heat on an iron plate about 200 c.c. of the water in a beaker of 500 c.c. capacity covered with a watch glass. The water is quickly heated until the air bubbles have all been driven off and the water about to boil. The beaker is then taken off the plate, and, after cooling for about five minutes, it is shaken by a rotary movement, the watch glass removed and the nose put inside the beaker. It is only for an instant, as a rule, that an odor can be perceived.

Determination of the Color.

Most of the surface waters of the State have a yellowish-brown color more or less pronounced. The tint corresponds, particularly in the lower grades, very closely to that of nesslerized ammonia, so that the standards for reading the ammonia can be used also for the determination of the color. The comparison is made in the same kind of 50 c.c. tubes that are used for the ammonia determinations, but the tubes used for this purpose are kept separate from those used for the ammonia, since the least amount of alkali remaining in a tube (if imperfectly washed), alters the color of the water. The scale used corresponds with the amount in the standards. Thus a color of 1.0 is that corresponding to the nesslerization of 1 c.c. of

the standard ammonium chloride solution ; 0.1 is the color produced with 0.1 c.c. of this solution. In the higher grades of color, over 1. the tint varies considerably from the nesslerized ammonia, and the degree of color is then better determined in wider tubes and in less depth. This method of estimating the color, which was originally suggested by Prof. A. R. Leeds, has its great advantage over arbitrary standards, in the fact that ammonia standards are always available in laboratories for water analysis, and also that the determinations have a definite value based on the amount of ammonia used.* Standards made from very dark water from cedar swamps by various degrees of dilution, and verified by direct comparison with nesslerized ammonia, have also been successfully used by Mrs. Richards. The color keeps well. If the water used in the standards contains organic matter in suspension, it may be freed from it completely by filtering through porous sandstone.

Determination of the Turbidity and Sediment.

The suspended matter remaining in the water after it has rested quietly in the collecting bottle for twelve hours or more is called its turbidity, and that which has settled to the bottom of the bottle its sediment.

Good ground waters are often entirely free from turbidity and sediment, but surface waters are seldom free from suspended matter. The turbidity is very various in character and amount, sometimes milky from clay, but more generally it consists of fine pollen-like particles. These are generally living algæ, and a practiced eye can, not infrequently, recognize their forms. Some of the lower animal forms can also be seen by the naked eye, and the larger entomostraca are quite noticeable in many waters.

The sediment may be earthy or flocculent, in the latter case it is generally debris of organic matter of various kinds. The degree of turbidity is expressed by the terms "very slight," "slight," "distinct" and "decided," and the degree of sediment by "very slight," "slight," "considerable" and "much."

* See paper "On the Color and Odor of Surface Waters," by Thomas M. Drown. Journ. N. E. Water Works Ass'n, December, 1887.

INTERPRETATION OF THE CHEMICAL ANALYSIS OF WATER.

In the examination of water we classify the substances found in it into mineral and organic. The distinction is not altogether a permanent one, for the mineral and organic are dependent on one another and, in part at least, pass into one another. From a sanitary standpoint our interest centres itself mainly in the organic matter. This we find, first, as living organisms, vegetable and animal, which either float in the water or have the power to move about in it; second, the products of organic life, such as albumen, urea, tissue, etc., which may be dissolved in the water or suspended in it; and, third, products of the decomposition of organic matter. In the last division are included salts of ammonia and of carbonic and nitric acids — mineral matters in fact — which serve in turn as food for the vegetable life in the water. It is the carbon and nitrogen of these compounds which are constantly oscillating between organic and mineral matter. Carbon and nitrogen in organic combination to-day may be found to-morrow as alkaline carbonates and nitrates. None of the other mineral compounds found in water bear this intimate relation to organic matter. These are potash, soda, lime, magnesia, iron and alumina, in combination with chlorine and sulphuric and silicic acids. The ordinary processes of analysis suffice for the accurate determination of all the mineral constituents of the water, but the determination of the amount and character of the organic matter contained in water is not generally practicable, so that indirect methods must be resorted to to indicate its presence and condition. This difficulty is in part due to the very small quantity of organic matter usually present in natural waters and also to the rapidity with which it decomposes and loses its original character.

The usual method adopted to get information with regard to the organic matter in water is to determine the amount and condition

of the nitrogen compounds, for it is the nitrogenous organic matter which has the greatest sanitary importance, owing not only to the facility with which it undergoes decomposition but also to the fact that nitrogen is an essential element in all living matter. Analytical processes of great accuracy enable us to determine nitrogen in four forms; namely, as organic nitrogen, as ammonia, as nitrous acid and as nitric acid. This order represents also the order of change from the organic state of the nitrogen to its most highly oxidized condition. A familiar instance is found in albumen, which contains about sixteen per cent. of nitrogen in organic combination. When this is exposed in solution to suitable conditions of decomposition, the nitrogen is first converted into ammonia and subsequently oxidized to nitrous acid and finally to nitric acid. This series of changes requires the presence of oxygen and of some alkaline or earthy base with which the acids can combine when formed. Further, the presence of micro-organisms is necessary to initiate and carry the processes through to completion.

Organic matter such as we are considering consists chiefly of carbon, hydrogen, nitrogen, and oxygen. The process of decomposition may be said to be, in a general way, first the oxidation of the carbon, which leaves the nitrogen combined with hydrogen in the form of ammonia, and subsequently the oxidation of the ammonia to water and nitric acid. Carbon takes precedence of the nitrogen in appropriating the oxygen, and the presence of ammonia represents therefore the first stage of the decomposition of nitrogenous organic matter. If we suppose, in any case, the carbon to be completely oxidized, the organic matter is destroyed as such, but the process once begun continues until the nitrogen is also oxidized. We must thus conceive the bacterial action of decay to continue even after the organic or organized character of a substance is lost; the process of decay of organic matter is, therefore, not to be considered complete until the nitrogen, as well as the carbon, has attained its highest degree of oxidation. It is not of course to be supposed that all the carbon of the organic matter is oxidized before the oxidation of any of the nitrogen begins: the two processes doubtless go on to some extent side by side; but, in general, it may be said that the organic nitrogen first passes through the state of ammonia before it is oxidized, and that the presence of ammonia indicates that a certain amount of carbon has been oxidized from the organic condition to carbonic acid.

Students of sanitary science have attempted to establish certain standards of purity of water based on the determination of nitrogen. These standards express limits for organic nitrogen, or albuminoid ammonia, free ammonia, nitrites and nitrates, beyond which the water containing them should not be used for drinking. Some of them have the sanction of sanitary congresses, and some are merely the expression of individual opinion. The application of these standards of purity has condemned many waters which were certainly unfit to drink, but it is equally certain that many wholesome waters have been thereby also rejected. The fallacy involved in making "standards of purity" based upon the organic nitrogen, ammonia, nitrites and nitrates, is apparent when we consider that these substances are not injurious in themselves, at least to the extent which they are found in natural waters, and that the presence of any one of these substances in water does not in itself necessarily carry with it any indication of its origin. These standards are relics of days in which the harmfulness of a water was supposed to be the direct result of the injurious action of specific substances found in it. The theory of to-day is that it is (in the large majority of cases) to the presence of micro-organisms in water that its harmful influence is due, and that the results of chemical analysis have their highest value in the light that they throw on the quality of the water from the standpoint of bacterial contamination. The use to which these determinations should be put, therefore, is to discover if possible the origin and history of the nitrogen compounds in the water. The study of the long series of results obtained in the analysis of waters of the State of widely different character and surroundings, together with the results obtained at the Lawrence Experiment Station of sewage purification by intermittent filtration, has broadened our views of the subject and has enabled us to break away from many of the traditions which have hitherto controlled the opinions of sanitarians.

To determine whether or not a water has been polluted by sewage, a chemical analysis is sometimes insufficient — sometimes it is superfluous. It does not need a chemical examination to decide whether a stream has been polluted by sewage when one can see the sewage flowing into it. In such case the determination of the nitrogen compounds is useful merely in the light which they throw on the amount and condition of the polluting material. There are many situations, however, particularly in ground waters the course of which may not be definitely known, where the results of chemical

analysis must be our main reliance in deciding whether a water is normal or polluted.

But in any case an opinion regarding the wholesomeness of a water must be based on all the information obtainable about it. In addition to the chemical and biological examination one should know the location, environment and source of the water and the character and population of the drainage area. The season of the year has an influence also (as will be seen later) on the condition of many waters. These facts, drawn from widely different sources, are all interdependent and help to interpret one another.

The value of an opinion as to the wholesomeness of a water is, unfortunately, often thought to be in inverse proportion to the knowledge which a chemist has of its origin; in other words, it is thought that a knowledge of the source of a water will bias a chemist in his examination. This notion, which is quite widespread, is founded on the mistaken idea that a chemist tests for definite harmful impurities in water as if searching for poisons, when the fact really is that the value of the results of a chemical examination depends entirely on the correctness of their interpretation.

We may sum up the conceivable methods in which a water may produce a disturbance of the normal functions as follows —

1. *The presence in the water of substances which have a direct disturbing influence on the system.* A familiar instance is recognized in the use of hard waters, or those with high mineral contents, by those accustomed to soft waters, and *vice versa.* This effect of change of waters is usually only temporary. Dissolved vegetable matter in large amount in water has been credited with injurious effects, often of a serious character. This may be owing to the vegetable matter having definite toxic properties like a drug, for instance, or it may be due to the vegetable matter being in a state of decomposition. Further, it is likewise conceivable that the presence of certain minute living animal and vegetable organisms in a water — algæ, infusoria and the like — may exert an injurious influence on health. Bad odors and tastes may of themselves, irrespective of their nature and origin, be injurious to persons of delicate constitutions.

2. *The presence of products of decay in the water.* It is well known that decaying animal and vegetable matters are unfit for food. In the process of decay, more particularly of animal matter, virulent poisons are often formed. The idea naturally suggests

itself that decomposition of organic matter going on in water may give rise to some of these poisonous compounds. While the idea is not inherently improbable, it yet lacks proof, and in the present state of our knowledge of these compounds it would seem incapable of confirmation except perhaps in a water so grossly polluted that it could not be classed with drinking waters.

3. *The presence of micro-organisms in the water.* All processes of decay or oxidation of organic matter going on in nature are accompanied by the vital activity of bacteria, and it is believed that the decay is the direct result of this activity. The bacteria which are the active agents of this oxidation, in which process organic matter is converted into mineral matter, are not known to have any injurious effect on the human system. It is conceivable, however, that when they are very abundant and active, as they must be in cases of active decomposition, the products of their life processes may exert an influence on the human system that would be inappreciable when their numbers are smaller. Again, in cases of active decomposition it may well be that other bacteria may be present besides those engaged in the oxidation of the carbon, hydrogen, and nitrogen of the organic matter, and that these may not be innocuous to health. It is supposed that each ptomaine is the result of the activity of a specific bacterium. Herein lies the possibility of danger greater than that involved in the formation of the ptomaines themselves; namely, the multiplication in the system of these specific bacteria accompanied with the generation of a large amount of poisonous compounds.

The presence of the waste products of human life in drinking water has long been recognized as the most serious of all forms of pollution. Instances of the harmful effect of drinking the waters of sewage-polluted streams and of wells contaminated with house drainage are sufficiently numerous to leave no doubt as to this causation of disease. In such cases, it must be borne in mind, we are dealing not only with the excreta of healthy persons but also, it may be, of the sick. In seeking for the cause of this harmful effect of sewage-polluted water, we find the most ready explanation in the presence of germs of disease. That illness should be caused by products of decomposition, of urea or the like, presupposes an amount of the substances which is rarely found in water which is acceptable for drinking. The sense of taste and of smell, it is well known, are no efficient safeguards against drinking

water which contains disease germs in great number and of great virulence.

In cities provided with an abundant water supply, the sewage is water containing less than one-tenth of one per cent. of foreign substances, a large proportion of which is mineral matter. The organic matter and the products of its decomposition rarely exceed one-twentieth of one per cent. of the weight of the sewage. Yet it is this very small quantity of decomposing matter that gives it its offensive character and also gives it its power either directly or indirectly of causing disease.

Characteristic of sewage is the condition of the nitrogenous matter. Its decomposition has been arrested by the failure of the oxygen supply in the water, and we have much free ammonia as a consequence of the oxidation of the organic carbon, but no oxidized compounds of nitrogen. Following is an average of daily analyses of the sewage of Lawrence for a year.

Analysis of Lawrence Sewage.

[Parts per 100,000.]

	Residue on Evaporation.			Ammonia.			Nitrogen as	
	Total.	Loss on Ignition.	Fixed.	Free.	Albuminoid.	Chlorine.	Nitrates.	Nitrites.
Sewage, unfiltered,	48.94	19.11	29.83	1.8202	.5302	5.25	.0000	.0000
Sewage, filtered through filter paper,	35.63	12.10	23.53	1.7710	.2675	5.25	.0000	.0000
Difference (suspended matter),	13.31	7.01	6.30	0.0492	.2627	0.00	.0000	.0000

Of the nitrogen compounds it is seen that free ammonia is largely in excess of the albuminoid ammonia, and that high chlorine and high contents of mineral matter are characteristic. When sewage is exposed to the action of oxygen, as when it mingles with the waters of a large stream, or percolates slowly through porous ground, oxidation takes place until all the carbon and nitrogen are oxidized, and the final result, when there are no disturbing conditions, is the conversion of the total nitrogen into nitrates, which are soluble in water. Recent pollution by sewage (using this term in a general way to express the waste of human life whether or not collected in sewers) is characterized by the presence in the water of

free ammonia and nitrites, and more remote pollution by the presence of nitrates.

In studying the effects of sewage contamination, we must distinguish sharply surface waters from ground waters. In surface waters, exposed to the air and to the action of the sun's light and heat, there are two actions going on; namely, the *oxidation* of the elements of the organic matter and their *absorption* by the various forms of vegetable and animal life, thus creating organic nitrogen in new and living forms. In porous ground are found the most favorable conditions for the oxidation of organic matter; here the bacteria of decomposition have their home, and the thin layers in which the water is exposed to the air facilitates the oxidizing process. In the absence of light, green plants cannot grow, and there is consequently no formation of organic nitrogen as in the case of surface waters. On the other hand, the forward movement of water in the ground is very slow as compared with surface streams, and there is thus opportunity for the accumulation within a limited area of the products of decay.

In the foregoing classification of waters we have had in mind the distinction between good and bad waters based on the absence or presence of sewage. The question of a public water supply involves also considerations of appearance, taste, color and odor of the water, which are often of equal importance, since a water which is unsightly, bad-tasting, and mal-odorous is not acceptable for drinking, even though injurious effects on the system cannot be ascribed to its use. These objectionable qualities in a water are due generally to dissolved vegetable matter or to vegetable and animal organisms the life of which is supported by organic and mineral matter in the water. The connection between the chemical composition of a water and the kind of life it will support is not yet well understood, but it is hoped that further accumulation of chemical and biological facts will enable us to know more of their relations to each other.

The characters of surface and ground waters are so radically different that a discussion of the interpretation of the results of analyses will be more profitable if we consider these two classes of waters separately.

Surface Waters.

Surface waters — brooks, rivers, ponds and lakes — have characters dependent on the regions which they have drained. The water

of a mountain stream flowing rapidly over rocky slopes will not differ much in composition from the rain which fell on the mountain. The water of a stream as it flows into the sea after draining many hundreds of square miles of surface is still the rain water of the drainage area, but it carries with it in solution and suspension mineral and organic matters of various kinds which it has collected in its onward flow.

The still or slowly moving bodies of water — as ponds, lakes and reservoirs — differ in an important particular from the streams, or water in more or less rapid motion, in that they afford better opportunity for the growth of algæ, which under favorable conditions is often so great as to make the water turbid and to give it a distinct odor and taste. This condition of affairs is seldom met with in streams.

In classifying waters from a sanitary standpoint, the most obvious and useful distinction is into waters which are polluted either directly or indirectly with sewage, or in general with the waste products of human life and industry, and those which are free from such contamination. The latter class of waters we will call *normal*. Normal waters may differ widely in character from the pure, colorless, mountain stream to the brown water of swamps, but they have this in common that they have never received any contamination connected with the life of man. It is not meant to be implied in this distinction that normal waters are necessarily good waters to drink, but they are never capable of producing those specific troubles which have their origin in disordered vital processes.

The chemical analysis alone may sometimes fail to distinguish a normal from a sewage-contaminated surface water. In the following table are grouped together the results of the analyses of several normal and polluted waters, which have been selected to show that in some cases not only is no single determination conclusive as regards the origin and quality of a water, but that all the determinations taken together do not always suffice to give us the information we desire.

Thus, among the polluted waters are found some in which the albuminoid ammonia is lower than in the waters which are unpolluted. The same is also true of the free ammonia, the nitrates, nitrites, chlorine, etc. Again, the great variation in the amounts of these substances, even among the normal waters, shows that we have to deal with facts that do not necessarily carry their interpretation with

them. But in all these cases a knowledge of the location and environment of these waters renders the results of the analyses intelligible, as we shall see later on.

TABLE OF WATER ANALYSES OF NORMAL AND POLLUTED SURFACE WATERS.

Normal Waters.

[Parts per 100,000.]

Number.	Appearance.			Residue on Evaporation.			Ammonia.		Chlorine.	Nitrogen as	
	Turbidity.	Sediment.	Color.	Total.	Loss on Ignition.	Fixed.	Free.	Albu-minoid.		Nitrates.	Nitrites.
1	None.	Very slight.	0.00	5.00	0.70	4.30	.0000	.0022	0.08	.0060	.0000
2	Decided.	Heavy.	0.10	2.50	0.95	1.55	.0000	.0702	0.10	.0030	.0006
3	Decided.	Slight.	0.60	5.15	3.25	1.90	.0000	.1252	0.11	.0000	.0000
4*	Slight.	Slight.	0.40	3.65	1.65	2.00	.0130	.0333	0.16	.0250	.0001
5	Slight.	None.	0.30	3.25	0.95	2.30	.0000	.0136	0.63	.0050	.0000
6	Slight.	None.	0.00	5.95	0.80	5.15	.0000	.0152	2.10	.0060	.0001

Polluted Waters.

1	Distinct.	Consid'ble.	0.10	10.75	2.05	8.70	.0124	.0284	0.19	.0150	.0009
2	Very slight.	Very slight.	0.55	5.15	1.95	3.20	.0000	.0196	0.54	.0550	.0004
3	Distinct.	Slight.	0.10	5.00	0.85	4.15	.0016	.0198	0.58	.0200	.0004
4	Slight.	Slight.	0.15	10.25	1.20	9.05	.0000	.0262	2.09	.0170	.0010
5*	Slight.	Slight.	0.15	12.70	2.10	10.60	.0664	.0263	2.41	·0800	.0025

* Another sample from the same source as the one immediately preceding.

Two substances are especially characteristic of fresh sewage, namely, free ammonia and chlorine; the latter is permanent, while the former, the ammonia, is ultimately oxidized into nitrites and nitrates. In looking for the evidence of sewage in a water, as shown in its contents of chlorine and ammonia, we must bear in mind the reduction in amount of both of these substances by dilution and also the loss of the latter by oxidation. There is also another source of loss of ammonia, namely, its absorption by growing plants. The experiment of adding sewage to vessels of water containing living algæ shows that the ammonia quickly disappears and that the plants grow luxuriantly. It is true there is the possi-

bility that the ammonia is first oxidized to nitrates before it is taken up by the plant; if so, the process goes on too rapidly to allow any accumulation of nitrates in the water. These two processes, namely, the oxidation of ammonia and its absorption by plant-life, are active in the "self-purification of streams."

The plant-life which is thus stimulated by the ammonia, appears in an analysis of water as albuminoid ammonia. Abundance of plant-life does not, however, prove the presence of sewage contamination. In two of the analyses, included among the normal waters in the table above, will be found excessive amounts of albuminoid ammonia. These are from a reservoir in which there is abundant food for the algæ in swampy waters, or in the organic matter of the muddy bottom.

Fortunately we are not without a clew as to the character and origin of waters in this State as the result of chemical analysis, and this we find in the amount of common salt in the water, or, as expressed in the results of analysis, in the chlorine.

Chlorine. — A comparison of the determinations of the chlorine in the waters of the State, made during the past two years, shows the interesting fact that there is a regular decrease in amount as we go from the seaboard westward. By selecting waters near their source, which we know from actual inspection are far removed from all sources of contamination, we are able to establish for many localities the *normal chlorine*. In a State as thickly settled as Massachusetts, it is not possible in all localities to get waters which we can say with positiveness are absolutely free from the drainage of human habitations, and, in some regions, the figures with which we have to content ourselves are probably somewhat too high.

The following table contains the chlorine determinations in some of the waters of the State which are nearly or quite free from human contamination. Here it will be noticed that the areas of low chlorine are all in the western part of the State, and that the amount increases as we approach salt water.

This is also conveniently shown on the map of "Normal Chlorine of Massachusetts," accompanying this report.

Table of Normal Chlorine.

[Parts per 100,000.]

	Number of Monthly Determinations.	Average Chlorine.	Extremes of Chlorine.
North Adams, Notch Brook,	11	.06	.02 — .09
Lenox, Reservoir,	12	.07	.04 — .09
Pittsfield, Sackett Brook,	6	.08	.07 — .10
Montague, Lake Pleasant,	21	.10	.07 — .16
Greenfield, Glen Brook,	12	.11	.05 — .16
Leominster, Haynes Reservoir,	21	.12	.08 — .16
Springfield, Ludlow Reservoir,	23	.12	.08 — .20
Worcester, Tatnuck Brook Reservoir,	23	.12	.08 — .16
Southbridge, Reservoir,	24	.13	.06 — .21
Fitchburg, Scott Reservoir,	24	.14	.10 — .19
Clinton, Lynde's Brook,	13	.16	.13 — .19
Hudson, Gates Pond,	24	.20	.16 — .23
Wayland, Snake Brook,	20	.23	.17 — .30
Boston Water Works, Ashland, Reservoir 4,	24	.23	.19 — .28
Haverhill, Kenoza Lake,	20	.34	.30 — .39
Danvers, Middleton Pond,	24	.35	.24 — .47
Fall River, Watuppa Lake,	24	.52	.48 — .63
New Bedford, Acushnet Reservoir,	24	.53	.46 — .67
Plymouth, Little South Pond,	7	.62	.56 — .68
Nantucket, Wannacomet Pond,	8	2.16	2.03 —2.25

It will be noticed that the variations in the amount of chlorine in many of these waters is very great at different times, amounting in some cases to 300 or 400 per cent., particularly in the waters lowest in chlorine. This is owing to variations in amount of rainfall, to the direction from which the rain comes and to the rate of evaporation. Too much weight therefore must not be attached to single determinations of chlorine, unless indeed the amount found is decidedly in excess of the maximum of the chlorine determinations in the normal water.

An interesting and instructive illustration of the use of this knowledge of the normal chlorine of definite regions of the State is found in the different sources of Boston's water supply. Lake Cochituate, and that portion of the Sudbury River drainage area which contributes to the supply of Boston, are so near together that we may assume the same normal of chlorine for the whole region. This normal we find in Snake Brook and Dudley Pond in

Wayland and Reservoir 4 in Ashland, these being bodies of water which drain regions with very little population. The chlorine of Snake Brook is 0.23 ; of Reservoir 4, 0.23 ; and Dudley Pond (three determinations only), 0.22. If now we average the other sources of Boston's supply in the order of their chlorine, we find that this order corresponds also with the amount of the population on the respective drainage areas : —

Reservoir 2, Framingham, Sudbury River,	0.31
Reservoir 3, Framingham, Stony Brook,	0.40
Lake Cochituate, Wayland,	0.44

The water as supplied to the consumer in Boston contains 0.41 parts of chlorine. The difference between this number and the normal of the region, namely 0.23, represents the effect of the population on the area on which the water is collected.

The Mystic Lake water, which is supplied to Charlestown and the neighboring towns of Chelsea, Everett and Somerville, has an average chlorine contents of 1.93, the normal of the region being under 0.50. This excess is caused by the extensive tanneries and the large population on this drainage area.

It must not be inferred that the amount of contamination of a stream, as indicated by the excess of chlorine over the normal of the region, is necessarily the result of *direct* access of sewage to the stream. The amount of chlorine in a stream above the normal is in direct proportion to the population on the area on which it has drained, whether the region has sewers or not : provided, of course, that the sewage is not carried outside the drainage area. But with regard to the organic matters the case is very different. When sewage flows directly into a stream there is direct pollution of the water by decomposing organic matter, whereas when house drainage reaches the stream after filtering through porous earth, the organic matter may have been entirely oxidized, and the water be purer, organically, than the stream into which it flows. But the chlorine in the waste waters suffers no change in filtering through the earth, and hence this evidence of "previous pollution" remains to tell the origin of the water.

In the case of Boston's water supply above mentioned, nearly all waste products of the population reached the reservoirs and Lake Cochituate indirectly during the time covered by this report. Sewers are now in operation in South Framingham, and the other towns

will in time be provided with them. When these improvements are completed, and the sewage is disposed of outside the drainage area of the Boston waters, the chlorine will sink to a point nearer the normal, even though the population on the area should increase.

In the determination of the nitrogen compounds in surface waters we have the indication of the amount, kind and condition of the organic matter which they contain — it may be in the form of living vegetable or animal organisms, in the form of soluble matters of vegetable or animal origin which the water has dissolved, or in the form of oxidized products of organic matter previously existing in the water. As already mentioned, four conditions of the nitrogen are determined, namely, albuminoid ammonia (organic nitrogen), ammonia, nitrates and nitrites.

Albuminoid Ammonia. — This represents the nitrogen which exists in organic combination before decomposition has set in. As determined in our usual practice, it is, in amount, about one-half of the ammonia which the total organic matter would be capable of yielding. The indication which this determination gives of the total amount of organic matter present in the water depends on the character of the nitrogenous matter. If we suppose it to be animal matter, like albumen, which contains about 16 per cent. of nitrogen, the total organic matter would be approximately determined by the formula $A \times \frac{14}{17} \times 2 \times 6\frac{1}{4}$, where A is the amount of albuminoid ammonia which the factor $\frac{14}{17}$ reduces to nitrogen; double this amount of nitrogen is the total organic nitrogen, and $6\frac{1}{4}$ times this amount is the total organic matter, which is assumed to contain sixteen per cent. of nitrogen. In cases of vegetable matter, such as suspended algæ or the brown matter dissolved from grass and leaves, the percentage of nitrogen is very much less, consequently the total amount of organic matter represented by the albuminoid ammonia would be very much larger.

The determination of albuminoid ammonia does not *in itself* convey any information as to the character of the organic matter in the water. Standards of purity based simply on the *amount* of albuminoid ammonia are of little or no value, since it is the quality of organic matter rather than its quantity that immediately concerns us.

A good illustration of this statement is found in the comparison

of certain normal and polluted waters. Thus the water from Reservoir No. 4, the purest of Boston's water supplies, has had an average contents of albuminoid ammonia for two years of .0260 parts per 100,000 (one foot below the surface), the highest for this period being .0328 and the lowest .0210. The water of Mystic Lake, the worst of the Boston waters, which is known to receive considerable sewage and manufacturing refuse has had, during this same time, an average contents of .0264 parts, the highest being 0.356 and the lowest .0184. Many instances of this kind could be cited to show that the determination of albuminoid ammonia needs to be interpreted with the aid of other determinations and with a knowledge of the source and general character of the water.

We distinguish with regard to the sources of the albuminoid ammonia: —

1st. Its animal or vegetable origin.

2d. The susceptibility of the organic nitrogenous matter to decay.

3d. The presence of the organic matter in solution or suspension.

It is generally conceded that matters of animal origin in water are more likely to be injurious than vegetable substances. This is probably owing to the fact that animal organic matter decomposes more rapidly, as a rule, than vegetable matter, and also because the products of animal decomposition are more apt to be, in themselves, injurious.

The attempt has been made, with only partial success, to distinguish between animal and vegetable matter in water by the relation which the carbon bears to the nitrogen — the proportion being usually greater in vegetable than in animal substances. But it is seldom that we need be in any doubt as to the presence of animal contamination in surface water. An inspection of the source and surroundings of the water will seldom fail to give us this information.

The susceptibility to decay of organic matter — whether of vegetable or animal origin — can, however, be determined by analysis; in other words, we can learn from successive examinations of a sample of water whether its organic contents decompose readily. Here is an important distinction, and one which has hitherto been largely ignored. By the usual standards of purity albuminoid ammonia, or organic nitrogen, has been regarded as representing so much organic matter with inherent possibilities of decay; the

facility with which decay takes place has not claimed the attention it deserves. For the more rapid the progress of decomposition, the greater must be the bacterial activity and the greater the likelihood of the accumulation of the products of decay in the water.

A most valuable result of the systematic examination of the water supplies of the State has been the recognition of this fact, namely, that certain kinds of nitrogenous organic matter found in natural waters are remarkably permanent in character. This is especially the case with the brown coloring matter which water dissolves from grasses, leaves, roots, etc. Most of the surface waters of the State are more or less colored. The water of the Acushnet River, the water supply of New Bedford, is one of the darkest waters of the State; its color varies from 0.70 to 2.30, and the albuminoid ammonia in the filtered water, entirely free from suspended matters, was, with the last mentioned color, .0296 parts in 100,000 — an amount sufficient to cause the water to be classed as "polluted" by most European standards. Experiments made with this water and others of the same general character show that this dissolved nitrogenous matter will remain constant in composition for months without the development of free ammonia or other indications of decay.

The following analytical results illustrate this statement: —

Analyses of Brown Waters indicating Permanence.

[Parts per 100,000]

	Color.	Ammonia.		Ammonia.		Ammonia.		Ammonia.	
		Free.	Albuminoid.	Free.	Albuminoid.	Free.	Albuminoid.	Free.	Albuminoid.
Taunton River, . . .	2.0	June 22. .0032	June 22. .0333	June 30. .0026	June 30. .0350	-	-	-	-
Taunton River, . . .	1.8	Aug. 12. .0042	Aug. 12. .0357	Aug. 24. .0038	Aug. 24. .0368	Sept. 2. .0008	Sept. 2. .0336	-	-
Cochituate Supply-Tap, .	0.4	Aug. 2. .0000	Aug. 2. .0172	Aug. 14. .0005	Aug. 14. .0164	Aug. 24. .0000	Aug. 24. .0142	Sept. 8. .0000	Sept. 8. .0150
Artificially prepared leaf solution, . . .	2.0	Oct. 21. 0.0018	Oct. 21. .0274	Dec. 8. .0014	Dec. 8. .0224	-	-	-	-

It is well known that brown, swampy waters were formerly often taken by sea captains going on long voyages on account of their keeping qualities.

It is still thought and asserted by some that the yield of ammonia on treating an organic compound with alkaline permanganate is an index of its susceptibility to decay under ordinary conditions. This

is not the case, for this stable brown coloring matter of swampy waters is readily attacked by the alkaline permanganate with the abundant formation of albuminoid ammonia.

In the case of the existence of vegetable matter in suspension in water, as, for instance, the algæ which grow abundantly in many surface waters, we cannot speak with as much confidence about its susceptibility to decay. It is not unlikely that in the great variety of vegetation found in surface waters there may be a wide difference in the duration of life and rapidity of decay; but from the fact that in the waters of normal ponds and reservoirs, where the algæ are very abundant, we do not find any marked tendency to the development of free ammonia — certainly not to an extent commensurate with the amount of organic nitrogen present — it might seem as if this class of vegetation did not under ordinary conditions decay rapidly. Thus if we look at the analyses of the water of Haynes Reservoir of Leominster (page 188), we find a very large amount of albuminoid ammonia — in one case as high as 0.1252 parts per 100,000 — and yet in only four months out of the twenty-two is the free ammonia over .0020, with an average for the twenty months of .0023. Another instance is found in the Ludlow Reservoir (Springfield) (page 298), where with albuminoid ammonia averaging .0381, and in one case rising as high as .0702 parts per 100,000, the free ammonia averages only .0019 for a period of twenty-one months, and during this time did not rise above .0054 parts.

But this evidence is not conclusive. It may still be the fact that, in these cases, the algæ do decay rapidly but that new growth absorbs the products of decomposition so that they do not accumulate in the water. Should this be the case we may perhaps conclude that the purifying action of the new growth neutralizes the injurious effects of the decay of the old. There are cases on record in which serious illness — diarrhœa, dysentery, low fevers — have been ascribed to the use of waters from swamps. Assuming this causation to be proved and that the waters were unpolluted, we must look for the immediate cause of the trouble in the peculiar nature of the organic matter itself, in the products of its decomposition, or in the presence of malarial or allied disease germs. Until these cases are thoroughly investigated both from the chemical and biological side we must remain in doubt as to their nature. None of the normal brown waters of this State used for public water supplies have the depth of color which is characteristic of the

water of some of the Southern swamps, and as far as we now know no ill effects have accompanied their use. That they are little liable to decomposition we have already seen, and it is interesting to note also in this connection that the actual amount of vegetable matter in solution in these waters is very small. In the case of the water of the Acushnet River, already referred to, the largest amount of dissolved organic matter (as shown by the loss on ignition) during the two years 1887–89, was 3.15 parts per 100,000, or 1.82 grains per gallon. Assuming the average consumption of water for drinking to be two quarts a day, one would take into his system in drinking water of this character less than a grain of vegetable matter daily.

Even in those cases where the water is turbid from an abundant growth of algæ, the actual amount of solid organic matter in suspension is much less than would generally be supposed. This is well illustrated by the following results, showing the condition of the water of Ludlow Reservoir in August for four years.*

Organic Matter in the Water of Ludlow Reservoir in August.

[Parts per 100,000.]

Year.	Albuminoid Ammonia.			Total Organic Matter in Suspension.
	Total.	In Solution.	In Suspension. (A)	$A \times 2.5 \times \frac{14}{17} \times 13.48$.
1876,	.0554	.0285	.0259	0.7180
1877,	.0474	.0292	.0182	0.5050
1888,	.0486	.0198	.0288	0.7990
1889,	.0738	.0239	.0499	1.3847

An actual determination of the amount of nitrogen in the dried organisms in the water of the reservoir (mostly blue-green algæ), gave 7.42 per cent., and it was also found, by experiment, that the total nitrogen of these organisms was about 2.5 times the yield of nitrogen as albuminoid ammonia. Hence, if we multiply (as has been done in the above table) the amount of albuminoid ammonia in suspension by $\frac{14}{17}$ to reduce the ammonia to nitrogen, then by 2.5 and finally by 13.48 (a factor based on the amount of nitrogen in the dried algæ, namely, 7.42 per cent.), we get an approximation

* From a special report of the State Board of Health to the Water Commissioners of Springfield, September, 1889.

to the actual amount of organic matter (in a dry condition) suspended in the water. If we take the highest amount, namely, that of August, 1889, we have only 1.3847 parts in 100,000, equivalent to 0.8 grain per gallon.

Shallow, stagnant bodies of water, which in the heat of summer are full of vegetable and animal life, become in time foul because decay gets ahead of growth and the products of decomposition accumulate. Such waters may be normal in the sense that they are free from human contamination, but no one would consider them fit to drink. We have had in mind in this discussion only bodies of water large enough to permit the changes of life, death and decay to go on normally.

Free Ammonia.—The expression "*free* ammonia" as used in water analysis is unfortunate, for there is no reason to suppose that ammonia exists in water (except under very unusual conditions) in the free state or as hydrate; it is undoubtedly present usually as carbonate or chloride. When water containing salts of ammonia is boiled, these salts are decomposed and free ammonia (or hydrate) is found in the distillate, hence probably the origin of the term. There need be, therefore, no misapprehension in the use of the term "free ammonia," which has the sanction of long usage and serves moreover to conveniently distinguish the saline from the albuminoid ammonia.

The significance of free ammonia in water is, as has already been fully explained, the evidence it affords of decomposition in progress, for ammonia may be regarded as a residue of organic nitrogenous matter after the carbon has been oxidized. It is the characteristic ingredient of sewage, which is polluted water from which most or all of the dissolved oxygen has been taken up by the carbon of nitrogenous organic matter with the abundant formation of ammonia.

An examination of the results of the analyses of the surface waters of the State shows that, broadly speaking, there is not much free ammonia in normal waters; in other words, that the balance between life and decay is such that this product of decomposition does not accumulate to any great extent in the water. In the surface waters, on the other hand, which are considerably contaminated by sewage, free ammonia is often persistently present; an indication that the amount of ammonia contributed by the sewage is, under the prevailing conditions, greater than can be absorbed by the growing plants or be oxidized into nitrates.

In the accompanying table there are given average determinations of free ammonia of twenty-four waters of ponds, lakes and reservoirs at different periods of the year. The order is that of the average amount of free ammonia in monthly determinations for two years. Most of these waters are normal or nearly so and some, particularly those near the end of the list, are more or less polluted by sewage or household drainage.

Free Ammonia in Surface Waters, Averages.

[Parts per 100,000.]

SOURCE OF WATER. PONDS OR RESERVOIRS.	Two Years, June, 1887, to May, 1889.	First Year, June, 1887, to May, 1888.	Second Year, June, 1888, to May, 1889.	Six Warmer Months, May to October. Two Years.	Six Colder Months, November to April. Two Years.	First Year, May to October.	Second Year, May to October.	First Year, November to April.	Second Year, November to April.
Fall River, Watuppa Lake,	.0005	.0007	.0003	.0003	.0006	.0005	.0001	.0008	.0004
Fitchburg, Scott Reservoir,	.0006	.0005	.0006	.0005	.0006	.0003	.0007	.0008	.0004
Marlborough, Lake Williams,	.0006	.0008	.0005	.0009	.0004	.0010	.0007	.0006	.0002
Malden, Spot Pond,	.0007	.0005	.0010	.0008	.0007	.0005	.0012	.0004	.0011
Danvers, Middleton Pond,	.0008	.0005	.0010	.0007	.0009	.0005	.0008	.0006	.0013
Worcester, Tatnuck Brook Reservoir,	.0009	.0014	.0004	.0005	.0012	.0006	.0004	.0021	.0003
Chicopee, Dingle Brook Reservoir,	.0010	.0015	.0005	.0006	.0014	.0007	.0005	.0021	.0006
Fitchburg, Overlook Reservoir,	.0012	.0017	.0007	.0003	.0020	.0002	.0004	.0033	.0009
Hudson, Gates Pond,	.0014	.0012	.0015	.0010	.0018	.0010	.0010	.0017	.0019
New Bedford, Acushnet Reservoir,	.0015	.0019	.0010	.0012	.0017	.0016	.0009	.0022	.0011
Salem, Wenham Lake,	.0018	.0019	.0017	.0020	.0016	.0025	.0014	.0013	.0020
Lynn, Breed's Pond,	.0018	.0024	.0011	.0006	.0030	.0005	.0006	.0043	.0016
Springfield, Ludlow Reservoir,	.0019	.0029	.0009	.0024	.0013	.0035	.0011	.0023	.0004
Lynn, Birch Pond,	.0019	.0030	.0008	.0010	.0028	.0009	.0010	.0051	.0005
Montague, Lake Pleasant,	.0021	.0030	.0011	.0007	.0035	.0008	.0005	.0053	.0018
Easthampton Reservoir,	.0021	.0020	.0022	.0027	.0016	.0018	.0035	.0022	.0010
Brockton, Salisbury Brook Reservoir,	.0028	.0030	.0022	.0023	.0028	.0020	.0026	.0041	.0015
Winchester, Storage Reservoir,	.0033	.0033	.0032	.0025	.0041	.0010	.0038	.0055	.0027
Worcester, Lynde Brook Reservoir,	.0040	.0050	.0031	.0029	.0050	.0029	.0029	.0068	.0033
Natick, Dug Pond,	.0050	.0070	.0032	.0020	.0087	.0021	.0020	.0140	.0042
Cambridge, Fresh Pond,	.0134	.0123	.0145	.0032	.0235	.0019	.0045	.0227	.0243
Woburn, Horn Pond,	.0152	.0214	.0090	.0056	.0240	.0053	.0059	.0377	.0104
Boston, Jamaica Pond,	.0157	.0205	.0113	.0034	.0300	.0053	.0015	.0387	.0211
Mystic Lake,	.0235	.0273	.0194	.0077	.0376	.0077	.0077	.0442	.0311
Averages,	.0043	.0052	.0034	.0019	.0067	.0018	.0019	.0087	.0048

The conclusions to be drawn from these determinations are: first, that those waters which receive house drainage, either directly or indirectly, are much higher in free ammonia than those that do not; and, second, that, during the colder months of the year, the ammonia is higher than during the warmer months. But there are so many exceptions to these general rules that one cannot claim for them universal applicability. In fact, the conditions which influence the development and accumulation of free ammonia in natural waters are so various that one must be extremely cautious in deciding what is the significance of its presence in individual cases. From the foregoing table of analyses it is seen that, even in normal waters, the average contents of free ammonia is not the same from year to year. Thus the average ammonia for the second year is considerably less than for the first, and reference to the last two columns shows that this difference is due to the lower ammonia in the colder months of the second year (1888–89). An explanation of this occurrence may perhaps be found in the fact that the winter of 1888–89 was exceptionally mild and very little ice was formed, so that growth of certain plants continued all winter.

In the table we find the average free ammonia for the six months, May to October, for two years to be .0019 parts per 100,000, and for the other six months .0067, or as 1 to 3.5. This difference is most marked in those waters which receive much nitrogen from outside sources, as is well shown in the last five waters on the list, in which the average relation of free ammonia in the warmer to the colder months is .0044 to .0248 or 1 to 5.6. In the other nineteen waters, most of which are normal or nearly so, the proportion is much lower, namely, .0013 to .0020 or 1 to 1.5.

The most obvious explanation of the lower free ammonia in the warmer months is the absorption of the ammonia by vegetation. The effect of water plants to purify even polluted waters has been already alluded to. Mystic Lake is a badly polluted body of water, and has generally much free ammonia and nitrates; and yet, when vegetation is very active in this water, the ammonia and nitrates are brought down to such a point that, from an analysis made at this time, one might be misled as to the character of the water if the large excess of chlorine above the normal did not indicate its pollution. Thus in the analysis of this water for August, 1888 (page 59), we find ammonia, none; nitrogen as nitrates, .0170. The average free

ammonia of the water for two years was .0238, and nitrogen as nitrates, .0496 parts per 100,000.

But there are many other conditions which influence the development or disappearance of ammonia in natural waters which must be taken into consideration. One of the most important of these is the circulation or stagnation of the water in lakes or reservoirs. As the atmosphere becomes colder, about the first of November, a downward current sets in from the surface, which descends to a depth where the water has the same temperature as the surface. In deep lakes of 40 feet or over, the temperature at the bottom is, in this State, about 45° F. the year round, so that the temperature of the surface must sink below this point before the whole body of water is in circulation. On the return of warm weather, when the surface of the water is heated by the atmosphere, circulation, due to differences in temperature, stops, and there would be complete stagnation if the wind did not turn the water over. This action of the wind does not extend below a depth of about 20 feet, consequently there is, in bodies of water of greater depth, a mass of stagnant water below this level which can only receive a limited amount of air through the contact of the water above it. When this mass of stagnant water contains much matter capable of undergoing decomposition, or when the bottom of the lake or reservoir is composed of mud full of organic impurities, this lower layer of water becomes very foul. Water drawn from near the bottom of such lakes contains, besides much ammonia, usually a large amount of offensive gases, such as sulphuretted and carburetted hydrogen, while dissolved oxygen is completely absent. In foul water of this character the varieties of animal and vegetable life which we find in the water nearer the surface are almost if not altogether absent, and bacteria are abundant.

It is easy to see how it is that the waters of some deep lakes show a decided increase of ammonia in the late fall and early winter, when the advent of cold weather puts these deeper layers into circulation. That these changes take place as described has been proved by determinations of temperature, together with chemical analyses of waters, taken at different depths in Jamaica Pond for a period of a year. The details of this investigation will be found in another place. Occasional examinations of samples of water taken during the summer near the bottom in other deep lakes have shown a like

condition of affairs, namely, foul smelling water with much free ammonia; an accumulation, in other words, of intermediate products of decomposition of nitrogenous organic matter, the hydrogen compounds of carbon, sulphur, phosphorus and nitrogen, which, owing to the exhaustion of the supply of free oxygen, cannot be further oxidized.

It must not be supposed, however, that the bottoms of all deep lakes are in this condition. In the absence of readily decomposable organic matter the water at the bottom will not differ much in composition from that at the top. The results of the analyses of the water of Reservoir 4 of the Boston supply at three depths — 1 foot, 20 feet and 40 feet below the surface, the latter being near the bottom (see pages 38 to 41) — show only a slightly higher average for free ammonia at the greater depths; there has never been any indication of active decomposition going on near the bottom even in the summer. In some of the shallower bodies of water not over 20 feet in depth, with much decomposing organic matter on the bottom, the water near the bottom may become very foul in summer during periods of calm weather when there is no circulation. After a sufficiently strong wind it will be found that this foul layer has disappeared and that the water is of the same composition at all depths.

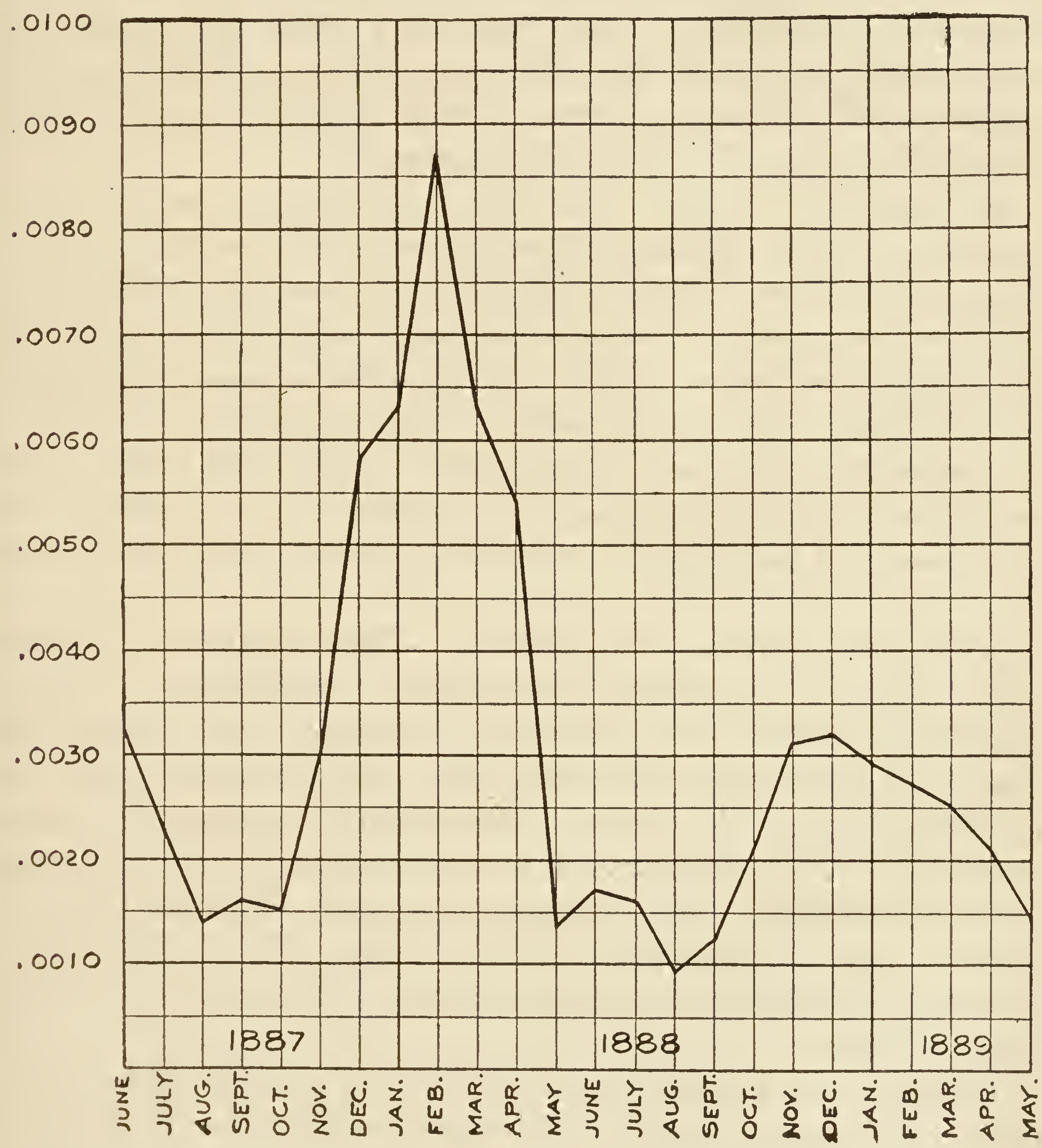
In the months of February and March, 1888, there was a very general and marked increase in the free ammonia in the surface waters throughout the State, which coincided with the breaking up of the ice. The following winter was much milder and ice was not formed until February, which lasted only a few weeks. The increase of free ammonia at this time was very much less marked than in the previous year. Three causes may have operated to account for this development of ammonia in the first year; namely, the less vegetable growth in the colder water, the melting of large quantities of snow and the exclusion of the air by the covering of ice. The effect of an ice-covering on a sewage-polluted stream has been shown by Prof. A. R. Leeds in the case of the Schuylkill River at Philadelphia in the winter of 1882–83. In this case the oxygen of the water was nearly exhausted, and there was an actual evolution of sulphuretted and carburetted hydrogen.*

In the following diagram there is shown graphically the average free ammonia in forty lakes, ponds, and reservoirs in this State for

* Annual report of Chief Engineer of the Philadelphia Water Department for 1883.

two years from June, 1887, to May, 1889. The high free ammonia of the early months of the first year is in strong contrast with that for the same period of the second year. Further examinations, in both mild and cold winters, will be necessary to decide whether this connection of great cold with high ammonia in ponds is regularly recurrent.

Diagram showing Average of Free Ammonia in Forty Ponds and Reservoirs for Two Years, June, 1887, to May, 1889.



In the foregoing discussion of the significance of free ammonia in surface waters we have had in mind almost exclusively quiet bodies of water—ponds, lakes and reservoirs—and not streams.

The conditions existing in flowing waters are so radically different from waters at rest (or with but very slight movement) that we cannot expect to discover in the analyses of river waters the same effect of climatic changes, of great depth, etc., which we have noted in ponds and reservoirs. In streams the entire body of water is in movement, and the inequalities of the bottom and sides of the stream tend to keep the water in a state of uniformity at all depths. The variations of level in streams are greater and more frequent than in ponds and lakes, since the flow of streams is more immediately dependent on rainfall. High water and rapid flow cause roily water by the washing of the banks and scouring of the bed of the stream, which, in water courses usually sluggish, may be thickly coated with mud and decomposing matters.

In seasons of drought and low water streams which receive sewage or similar drainage show relatively more pollution than in times of high water. This condition goes to neutralize the tendency which we have noted in the quiet bodies of water towards lower free ammonia in the warmer months, owing to the increase of vegetation in the water. The interpretation of the presence and amount of free ammonia in streams must therefore be governed largely by the population on the drainage area, the amount of sewage flowing into the stream and the height of water at the time of taking the sample.

Nitrogen as Nitrates and Nitrites. — The oxidation of ammonia which goes on in natural waters under the influence of micro-organisms results in the conversion of all of the hydrogen into water and the nitrogen into nitric acid, which combines with soda, potash or lime in the water. Intermediate between the ammonia and nitric acid is nitrous acid, a lower state of oxidation through which (presumably) the nitrogen must pass before it attains its highest stage of oxidation in nitric acid. The combinations of nitrous acid with bases are called nitrites; those of nitric acid with bases, nitrates.

The significance of the nitrates in water is primarily this, namely, the complete mineralization of the organic matter of which this nitrogen was a part. The inference may seem justified that the danger from organic contamination is past when the organic matter has ceased to exist. This is obviously the case if the organic matter itself is the source of the danger. But, in those cases in which we have reason

to suspect the presence of disease germs apart from the organic contamination of the water, there is no necessary connection between the oxidation of the organic matter and the death of the disease germs. To decide, therefore, whether the nitrates in a water indicate danger we must know the origin of this nitrogen. The nitrates in normal waters represent simply one stage of the cycle of change of nitrogenous matter; the nitrogen we find as nitrates was, it may be, a few hours before in organized matter and a few hours later may be again a part of a living organism. It is as much a source of life as a product of decay. The total nitrogen of a body of normal surface water is distributed differently at different times; at one season it is mainly in the form of organic nitrogen, at another it may be in the form of ammonia, and again at another in the form of nitrates. If we leave out of consideration those exceptional cases where decomposition goes on at great depth with insufficient oxygen, we do not certainly know whether the condition of the nitrogen in a *normal* water has any sanitary significance. Still we are probably right in supposing that the two extremes — namely, nitrogen in a stable organic condition and nitrogen as nitrates — are the most favorable sanitary conditions, and that the intermediate stages — namely, ammonia and nitrites, representing the condition of change of organic matter — are less favorable, since they indicate the presence of the active agents of this change and also perhaps the accumulation of the products of decay.

Let us suppose that, in the sewage which flows into a stream, we have, besides much decomposing animal matter, the bacteria of a specific disease. The water, when freshly contaminated with this sewage, gives evidence, in the free ammonia, of recent pollution, and we may then reasonably suppose that there would be great danger in drinking the water. After many miles of flow of the stream, the free ammonia will perhaps have disappeared and the water will show an increase of nitrates from its oxidation. The specific germs have had (probably) nothing to do with these changes and the only bearing that chemical analysis has on their presence or absence in the water is the indication it affords of the time that has elapsed since the sewage entered the stream and the amount of dilution.

"Previous sewage contamination," a term proposed by Frankland, expresses well the significance of the nitrates in such a case; but the extension of this idea, namely, that "once polluted is

always polluted" is not true chemically, nor is it probably true in a sanitary sense. Still the time required for the chemical changes involved in the oxidation of the nitrogenous matter of the sewage or its absorption by growing plants is not inconsiderable, and we have no means of knowing with certainty in surface waters when they are complete.

The amount of nitrogen in the form of nitrates in normal surface waters is not usually great, but it is seldom that nitrates are completely absent. The average amount of nitrogen as nitrates in any water is almost always greater than that present as free ammonia, but there is no constant relation between the nitrogen in the two conditions.

In the accompanying table may be seen the average nitrogen as nitrates and nitrites in the same waters and in the same order in which the free ammonia was given, on page 551. It will be noticed that the order of increasing nitrates is not the same as for the free ammonia in these waters, although the lower members on the list, which include the waters which are more or less contaminated by house drainage, are noticeably higher in nitrates than the normal waters.

Nitrogen as Nitrates and Nitrites in Surface Waters, Averages.

[Parts per 100,000.]

SOURCE OF WATER. PONDS AND RESERVOIRS.	NITROGEN AS NITRATES.			NITROGEN AS NITRITES.		
	Average, Two Years, June, 1887, to May, 1889.	Six Warmer Mos., May to October, for Two Years.	Six Colder Mos., November to April, for Two Years.	Average, One Year, May, 1888, to April, 1889.	Six Warmer Mos., May to October.	Six Colder Mos., November to April.
Fall River, Watuppa Lake,	.0055	.0042	.0066	.00013	.00005	.00021
Fitchburg, Scott Reservoir,	.0034	.0020	.0047	.00014	.00010	.00017
Marlborough, Lake Williams,	.0053	.0024	.0081	.00012	.00007	.00018
Malden, Spot Pond,	.0044	.0035	.0055	.00015	.00007	.00023
Danvers, Middleton Pond,	.0049	.0044	.0053	.00010	.00008	.00012
Worcester, Tatnuck Brook Reservoir,	.0038	.0031	.0046	.00011	.00008	.00015
Chicopee, Dingle Brook Reservoir,	.0138	.0072	.0203	.00024	.00020	.00027
Fitchburg, Overlook Reservoir,	.0041	.0020	.0062	.00012	.00008	.00017
Hudson, Gates Pond,	.0056	.0036	.0076	.00009	.00013	.00005
New Bedford, Acushnet Reservoir,	.0150	.0130	.0172	.00016	.00015	.00017
Salem, Wenham Lake,	.0047	.0025	.0070	.00012	.00010	.00015
Lynn, Breed's Pond,	.0042	.0021	.0062	.00019	.00015	.00022
Springfield, Ludlow Reservoir,	.0039	.0029	.0043	.00021	.00018	.00025
Lynn, Birch Pond,	.0065	.0035	.0092	.00016	.00015	.00018
Montague, Lake Pleasant,	.0064	.0027	.0098	.00004	.00002	.00007
Easthampton Reservoir,	.0140	.0078	.0191	.00022	.00017	.00027
Brockton, Salisbury Brook Reservoir,	.0058	.0046	.0078	.00012	.00010	.00013
Winchester, Storage Reservoir,	.0104	.0070	.0140	.00032	.00030	.00033
Worcester, Lynde Brook Reservoir,	.0062	.0044	.0078	.00018	.00013	.00023
Natick, Dug Pond,	.0238	.0104	.0315	.00042	.00035	.00048
Cambridge, Fresh Pond,	.0281	.0262	.0301	.00072	.00066	.00079
Woburn, Horn Pond,	.0452	.0200	.0704	.00132	.00098	.00166
Boston, Jamaica Pond,	.0160	.0048	.0263	.00034	.00023	.00035
Mystic Lake,	.0496	.0292	.0703	.00162	.00175	.00150
Averages,	.0128	.0072	.0167	.00031	.00027	.00035

As in the case of free ammonia, a decided difference between the warmer and colder months of the year is noticed in the amount of the nitrates. Here, again, we think we make no mistake in explaining the lower nitrates in warm weather by the more abundant vegetation. This explanation has the support of actual experiment in the laboratory, where growing algæ have been placed in water with known contents of nitrates, with the result that the growing plants have absorbed the nitrates almost completely.

This may be also observed on a large scale in those cases where a ground water with abundant nitrates is exposed to air and light in open reservoirs. Under these conditions there is generally a rapid development of vegetable organisms, and analysis shows that this growth is supported by the nitrates in the water, which disappear in proportion as the organisms increase. Interesting instances of this may be found in the records of analyses in the preceding pages of ground waters in their natural condition and after exposure in open reservoirs, where it will be seen that the nitrates in the reservoir are lower than in the water as it exists in the ground, and that the albuminoid ammonia is higher, owing to this vegetable growth.*

The algæ which thrive in this ground water, when exposed to the air and light, often impart to the water a strong odor, which is sometimes so repellent as to make the water unfit for drinking. Fortunately there is a simple remedy to prevent the growth of the algæ, namely, the protection of the water from light by covering the reservoir. In the high-service tank of the Brookline Water Works this has been done, with the result that the water is preserved in its original condition. This may be seen by comparing the analyses of the water as pumped from the filter-gallery, as supplied from this tank and as supplied from the low-service open reservoir (see pages 81–84).†

Experiments have also been made with the ground water supply of Hyde Park, by protecting the water in the gate house from the light. It was found that, while in the water in the open reservoir there was abundant growth of algæ with nearly complete exhaustion of the nitrates, the water in the gate house was practically unchanged. A covered tank is now being built by the Hyde Park Water Company to replace the open reservoir.

The intermediate condition of oxidation between ammonia and nitric acid, namely nitrous acid, is not usually present in surface waters to any large extent. In looking over the foregoing table, it will be noticed that the average amount of nitrogen in the form of nitrites for one year in the twenty-four waters is only .00031 parts per 100,000.

* Following are some of the cases above referred to: Ayer, pp. 26, 27; Brookline, pp. 81–83; Cohasset, pp. 105–107; Hyde Park, pp. 163–165; Waltham, pp. 324–326; Woburn, pp. 367–369.

† See Report of Mr. G. H. Parker, following.

The extremes, however, are very far apart; the lowest being .00004 parts per 100,000 in the water of Lake Pleasant and the highest .00162 in the water of Mystic Lake, a relation of 1 to 40. In this respect the nitrites resemble the free ammonia, which in this set of twenty-four waters varies widely. Thus the lowest free ammonia is .0005 for Watuppa Lake and the highest .0235 for Mystic Lake, or 1 to 47. In contrast to this wide variation of the nitrites and ammonia is the more limited range of the nitrates, which vary from .0034 in the water of Scott Reservoir in Fitchburg to .0496 in Mystic Lake, or as 1 to 15.

Notwithstanding the very small amount of nitrogen as nitrites in surface waters, even those which are considerably polluted, its presence is of great significance. It will be seen from the table that only four of the waters have an average contents of nitrogen as nitrites over .0004, and these are known to receive, directly or indirectly, considerable drainage; and the two waters which are over .0010, namely, Horn Pond and Mystic Lake, receive sewage directly in considerable quantities.

The difference between the warmer and the colder months is not, as a rule, so marked in the case of nitrites as in that of nitrates and free ammonia; the significance of the nitrites as an index of pollution is, therefore, less dependent on the season of the year.

When we speak of a water having "high" nitrites, we have in mind the general low contents of nitrites in surface waters. The actual amount which would be called "high" in this case might be low if applied to ammonia or to nitrates. Thus .0010 parts in 100,000 of nitrogen as ammonia we would call "low;" as nitrites it would be "high," as nitrates "very low."

High free ammonia and high nitrites together are characteristic of recent pollution, and when they are uniformly high in a surface water they point to continuous pollution. In connection with chlorine above the normal they afford complete proof of sewage contamination. When, however, the chlorine is not much above the normal in waters which show high free ammonia and nitrites, the inference to be drawn from these products of decomposition is that we have to do with pollution from farm yards or from manured fields; a distinction which it is frequently very important to make.

On the maps of the Hoosac, Housatonic and Nashua rivers (pages 423, 431, 472) are given the results of special examinations of the water of these streams below points of known pollution by sewage.

Within the squares are figures representing the free ammonia, chlorine, and nitrogen as nitrites at different points on these rivers. In every case of recent pollution by sewage in these streams the increase of all three of these substances is noted; and their subsequent decrease, at points lower down in the stream, is owing to dilution and to the further oxidation of the nitrogen to nitrates.

In the waters of Horn Pond and Mystic Lake we have (pages 369 and 59) instances of continuous animal pollution from the extensive tanneries and from the drainage of a large population in the Mystic valley. An extreme case is found in the water of Stacy's Brook in Swampscott, — a stream continuously and badly polluted by house drainage, — in which the average nitrogen as nitrites for eighteen months was .0069 parts per 100,000, varying from .0012 to .0200.

In the foregoing discussion we have assumed the nitrogen present in water to have its source in animal and vegetable life; that is to say, we have assumed the sanitary significance of this nitrogen to be in some way connected with organisms and the products of their decomposition. There is another direct source of this nitrogen, namely, the ammonia and nitrates in the rain. Rain water always contains free ammonia, that falling in cities containing more usually than that which falls in the open country.

Following are some analyses of rain from different localities: —

Analyses of Rain Water.

[Parts per 100,000.]

Date.	Collected at	Ammonia.		Nitrogen as		Chlorine.
		Free.	Albuminoid.	Nitrates.	Nitrites.	
1888.						
July 7, . .	North Andover, ...	.0047	.0038	.0070	.0000	–
Sept. 18, . .	North Andover, ...	.0016	.0026	.0040	.0000	–
Sept. 21, . .	Lawrence, ...	.0298	.0024	.0000	.0000	.007
Oct. 2, . .	Lawrence, ...	.0414	.0030	.0100	.0000	–
Nov. 27, . .	Lawrence, ...	.0164	.0014	.0050	.0002	.360
1889.						
May 21, . .	Lawrence, ...	.0086	.0026	.0030	.0001	.070
June 17, . .	Jamaica Plain, Boston, . .	.0564	.0152	.0180	.0004	.130
1890.						
Mar. 28, . .	Newton Highlands, . . .	.0154	.0034	.0050	.0001	.060
1887.						
Dec. 26, . .	Boston (Snow), ...	.0258	.0038	.0030	–	–

Warrington gives the average amount of ammonia in the monthly rainfall at Rothamstead in England as 0.0425 part per 100,000, which is equal to 2.4 pounds of nitrogen on the acre with a rainfall of 30.22 inches. The amount of organic and nitric nitrogen in rain is not insignificant, but it seldom equals that in the form of ammonia.

When rain, particularly that first falling, is collected in a clean glass bottle, it is seen to be quite dirty. In cities where the air is full of soot this is very marked, but even in the open country the floating matter in the atmosphere is considerable. At the close of a protracted rain, the water may be nearly or quite clear, since the air has then been washed clean; and the ammonia is also less than at the beginning of the rainfall. A part of the ammonia in the rain water has its origin in the direct formation of ammonia from the nitrogen of the air and the hydrogen of the watery vapor, but its main source is undoubtedly in animal exhalations, fine particles of organic dust, gaseous products of decay, etc.

Although the amount of ammonia in rain water is often quite large, yet the effect of any one rainfall on the amount of the ammonia in large bodies of water is scarcely noticeable. In the case of streams the effect of heavy rains in washing the banks and stirring up the bottoms would probably influence the amount of ammonia in the water more than the ammonia contained in the rain itself. In the rapid melting of large bodies of snow during the spring it is not unlikely that the ammonia thus contributed to streams and ponds may be appreciable. But on this point we lack experimental data.

Rain water stored in cool under-ground cisterns protected from the light often preserves its high free ammonia. In such cases we must assume the absence of active nitrifying conditions. Practice differs in different places in the collection and storage of rain water. In some places it is merely allowed to settle and (after a so-called period of "fermentation," in which process the organic matter is oxidized) to come to a stable condition. In others the water is filtered through a fine porous material such as brick. In any case the first portion of the rainfall should run to waste, since it not only contains the dirt in the atmosphere but also that on the collecting surfaces. Rain water collected from clean surfaces carefully stored and protected from access of surface and ground water is believed to be one of the most wholesome of water supplies. We do not, therefore, attach the same importance to the presence of free

ammonia in rain water that we do in the case of surface and ground waters. If disease germs should be in the air, it is probable that they would also be in the collected rain; but of this mode of the causation of disease it cannot be said that we have as yet any evidence.

The Residue of Evaporation. — The amount of dissolved mineral matter in normal waters depends on the character of the rocks and soils over and through which the waters flow, and also on the time of contact with the rocks. Silicious rocks are attacked very slightly by natural waters, but the limestones, both pure and magnesian, are dissolved quite readily, the lime and magnesia going into solution as bicarbonates. The older rocks and drift in Massachusetts are mainly silicious and give up very little mineral matter to the rain that flows over them and percolates through them. In the eastern and central part of the State the fixed solids of the normal surface waters are very low, seldom reaching 4 parts per 100,000 (or 2.34 grains per gallon) and in many cases not half this amount. In the limestone formations, in the western part of the State, the fixed solids are somewhat higher, but they seldom exceed 5 or 6 parts per 100,000 in normal waters.

The hardness of a water depends on the amount of dissolved lime and magnesia, which (particularly the lime) have the property of making a curd with soap and preventing the formation of a lather until all the lime and magnesia have entered into combination with the fat acids of the soap. It will be seen in the tabulated results of analyses of the waters of the State that most of the normal surface waters have a hardness under 2, and many under 1. Some of the hardest of the normal waters are as follows: —

Mohawk Lake, Stockbridge,	11.5
Dry Brook Storage Reservoir, Adams,	5.1
Tannery Brook, Holyoke,	4.0
Distributing Reservoir, Lenox,	3.4
Glen Brook Storage Reservoir, Greenfield,	2.6

— all in the western part of the State. With the exception of the first mentioned these waters would all be considered soft in comparison with the water supplies of many States, where, as in central New York, Michigan and Wisconsin, there are extensive limestone and gypsum formations.

Surface waters which receive the drainage of regions with large population contain more dissolved mineral matter than the normal

waters of the locality. In the analysis of sewage given on page 538 it will be seen that the fixed solids in solution are 23.53 parts per 100,000, which is much higher than is found in any of the surface waters of the State. The effect of even a comparatively small amount of sewage or house drainage is consequently noticeable in the increase of the mineral contents of the streams. Thus the normal fixed solids of the Sudbury River are represented probably by Reservoir No. 4 in Ashland, namely, 2.39 parts per 100,000 (average of three depths), with a hardness of 1.3. Stony Brook, which supplies Reservoir No. 3, receives a good deal of drainage, directly and indirectly, from the considerable population on its drainage area, and we find its fixed solids to be 4.73, with a hardness of 1.8. Instances of still more marked pollution in another drainage area are Horn Pond and Mystic Lake, in which the fixed solids are 10.87 and 9.09 respectively, with hardness of 3.1 and 3.4.

The question of the sanitary importance of dissolved mineral matter in surface waters is one of which but little need be said. In this State the amount is, in all the water supplies, much less than that contained in many approved water supplies in other parts of the world. A comparison of the death rates of cities in England based on the use of soft and hard drinking waters did not point to any essential difference. It has been claimed by some that the use of hard waters is advantageous by reason of the lime they contain, but this notion seems rather fanciful when we reflect what a small contribution to the formation of bones the use of a moderately hard water would be.

The "loss on ignition" of the solid residue on evaporation of surface waters, when the operation is performed as described in the "Methods of Analysis," gives a close approximation to the total organic matter in the water irrespective of its character. We attach comparatively little significance to this determination from a sanitary point of view, since we get from it but little light on the nature of the organic matter present. The behavior on ignition is however somewhat significant. Thus swampy waters give a brown residue on evaporation to dryness, which blackens or chars on ignition, and this black substance burns off quite slowly. The odor of the charring is peaty, or like charring wood; sometimes sweetish, but not offensive. Waters much polluted by sewage blacken slightly, the black particles burn off quickly and the odor is disagreeable. Taken by themselves the results of the ignition of

the solid residue are not decisive of the character of the water, but they are useful as supplementing and confirming the results of the nitrogen determinations.

Turbidity and Sediment. — A careful inspection of waters in a large white glass bottle will reveal, even to the unaided eye, the general character of the suspended matters in the water. Many of the vegetable and animal organisms usually called microscopic can be recognized by the trained observer. But any one can with a little experience distinguish the larger organisms, the flocculent debris of organic matter, the milkiness that comes from clay and that which comes from sewage, and the earthy sediment. In some cases we may be able to draw important conclusions from the inspection alone, but it is mainly valuable when taken in connection with the chemical analysis of the filtered and unfiltered water and supplemented by a thorough microscopical examination.

The sanitary significance of the presence of living organisms in the water rests chiefly on the fact that, when an organism is manifestly thriving in a water, there must be present an abundant and appropriate food supply. Thus the presence of green algæ indicates that there is food for them in the mineral constituents of the water (including ammonia and nitrates), while certain infusoria which do duty as scavengers in water point to the existence of organic matter undergoing decay. But this subject belongs properly to the biologist, and need not be further discussed here.

Color. — The color we observe in surface waters is derived from leaves and grasses and peat. Long contact of the water with the vegetation of swamps gives it a deep yellowish-brown color. It has already been mentioned that this coloring matter, which contains considerable nitrogen, is remarkably permanent; that is to say, it has but little tendency to oxidize under ordinary conditions.

There is a general correspondence between the depth of color and the amount of dissolved organic nitrogen in the water; or, in other words, the amount of albuminoid ammonia increases, generally, with the depth of the color. There are, however, many exceptions to the rule, which the following experiments on leaves and peat may perhaps serve to explain. By treating fresh, clean autumn leaves with distilled water, it was found that the first extract (which is rather more yellow and less brown) was much more highly nitrogenous for the same depth of color than those made by subsequent treatments with water. Different leaves, — as maple, oak and elm,

— it was also found, give to water by identical treatment different degrees of color and albuminoid ammonia. Old peat yields to water much less nitrogenous matter in proportion to the color than do the fresh leaves.

The nitrogenous character of this brown coloring matter may be shown by treatment of the water with hydrate of alumina, which combines with the coloring matter and gives a colorless water when the alumina settles or is filtered out. The following table gives a summary of the results of analyses of these artificial solutions of coloring matters and also of some natural waters : —

Relation of Color to Albuminoid Ammonia.

	Color.	Albuminoid Ammonia.	Albuminoid Ammonia after Decolorizing with Alumina.	Per Cent. of Albuminoid Ammonia removed.
Peat solution,	2.0	.0516	.0136	73.7
Fresh leaf solution,	0.8	.0494	.0100	79.8
Second extract of same leaves,	0.8	.0174	.0036	79.3
Solution of old leaves which had been repeatedly extracted with water,	0.9	.0072	.0018	75.0
Middleton Pond,	0.6	.0224	.0042	81.3
Assabet River,	1.4	.0348	.0040	88.5
Taunton River,	2.5	.0400	.0064	84.0

Odor. — Pure water is odorless ; consequently waters which have a perceptible odor are not acceptable for drinking. Except in cases where the odor is very faint it does not require any special apparatus, skill, or experience to detect an odor in water; hence the judgment of one is as good as another in this respect. But, in drawing inferences as to the origin and significance of an odor, the judgment may go very far astray.

Most normal surface waters in Massachusetts, particularly those which are colored, have a perceptible odor when examined in the way described under the "Methods of Analysis." This odor may be said, in general, to be *vegetable* — swampy, marshy, pond-like, grassy ; and it is often persistent when the water is heated.

When the odor which we perceive in a natural water is due to dissolved gases, the odor will disappear when the water is boiled. If water does not contain any organic matter capable of generating more of the same gases, then the odor is removed by boiling

once for all; but, if dissolved or suspended matter in the water is the source of the odor, then it may develop again in time. Following is an interesting experiment bearing on this point. Many waters with abundant growth of algæ have a decided vegetable or grassy odor which is intensified by long continued boiling. If in such waters the algæ be filtered out before the water is heated, there will be absolutely no odor when the water is brought to a boil. In such a case it is clear that the suspended algæ are the source of the odor, and the fact that the same odorous products can be distilled out by long continued heating seems to point to the fact that the odor is inherent in the organisms themselves.

This distinction between the odor cold and hot — between the odor which exists ready formed in water and that which it is capable of developing when heated — may sometimes lead to valuable results in investigating the nature and condition of the organic matter in solution and in suspension in the water.

Many normal waters have at times pronounced *disagreeable* odors; this condition is popularly referred to decay of some kind going on in the water. On this point there is a difference of opinion among water analysts and biologists.

The writer has been disposed to regard these odors as frequently, if not generally, the odors of the organisms themselves rather than the result of their decay. This has seemed to him probable, first, because the odors are not usually of a kind that (to him) suggest decay; second, because the odor is frequently persistent on long continued heating of the water, indicating that the odor was being distilled out of the organisms; and, third, because of the absence of free ammonia — one of the first products of decay — in many cases where the odor is very strong.

It is not unusual to have an odor described by different persons in different ways. The odor which often accompanies an abundant development of diatoms affords a good illustration. It will be called offensive, rotten, fishy, geranium-like, aromatic, in one and the same sample of water. For those who find the odor offensive, the water is unfit to drink; to those who merely perceive a slight aromatic odor, the water is unobjectionable. In most cases of this kind there is no chemical evidence of decay going on. The argument based on the absence of products of decay may not however be conclusive when we consider the penetrating character of some odors; that is to say, the actual amount of organic matter in

the state of decay may be so small as to be inappreciable to chemical tests and yet communicate a bad odor to the water.

Some odors are known to be result of decay; for instance, the pig-pen odor comes from the decay of the jelly of the blue-green algæ, and the bad odor of the Boston water in 1881 was referred by Professor Remsen to the decomposition of a fresh-water sponge.

The foul condition of the water near the bottom in some ponds and reservoirs has already been alluded to. This is due to putrefaction of organic matter when there is little or no dissolved oxygen in the water. But it is not odors of this kind which we now have in mind.

Mr. G. H. Parker, in his "Report on the Organisms in the Waters," has arrived at the conclusion, from a study of the recorded odors and the observed organisms, that the disagreeable odors are generally the evidence of the decay of the organisms. It is unfortunate that there should be any uncertainty about the cause and significance of these odors, for it immediately concerns the well being of many large communities dependent on surface water supplies. The subject is under investigation by engineers, biologists, and chemists in many localities with the hope of discovering the causes of the trouble and suggesting remedies for relief.

The odor that comes from sewage contamination in water is very different from that class of odors which we have been considering. A stream badly polluted by sewage, such as the Blackstone at Millbury, has more or less the odor of sewage itself. In more dilute condition the odor is musty, both cold and hot; this is quite characteristic. But it must not be supposed that the sense of smell furnishes us with a delicate test for the detection of sewage contamination. When we perceive this mustiness even faintly, the water is generally badly polluted, considered from the standpoint of a drinking water. Still greater dilution of the sewage will give a mouldy odor, but this is not characteristic. Many normal surface waters acquire a mouldy odor on standing, and the odor of diatoms and other algæ is by some called mouldy.

Ground Waters.

The appearance and composition of ground waters are so radically different from surface waters that they cannot be judged by the same standards. Normal surface waters, exposed to light and air, may contain organic matter in considerable quantity both in solution

and suspension, may be deeply colored and may abound in living vegetable and animal organisms. Normal ground waters, from which light is excluded and to which air may have scanty or no access, should have no color, no life, no suspended matter and little or no organic matter in solution.

Surface and ground waters do not have an independent existence; they both have their origin in rain and both flow towards the sea. Surface waters, when they percolate into the soil or run into rock fissures, become ground waters, which in turn feed the streams and maintain the regularity of their flow.

But, notwithstanding this interchange of position, the two classes of waters are sharply distinguished from each other, a change of character accompanying a change to or from the surface. Thus ponds which are largely fed by springs and receive but little water from the surface bear evidence of their sub-surface origin in absence of color and it may be also in higher mineral contents, but they will always have some aquatic life as the result of exposure to light and air. On the other hand, surface waters which filter slowly and for a considerable distance through porous soil are not only freed from suspended matter but their organic contents are destroyed by oxidation; and colorless, clear and odorless water is the result.

The soil best adapted for this combined process of filtration and oxidation is one of considerable porosity, sandy or gravelly in character, throughout which the water may be exposed in thin layers to the oxidizing action of the air. Too coarse and too fine material are alike unfavorable; the former permits too rapid flow of the water, the latter does not give sufficient access of air. In open, seamy rocks water may descend to great depths with little or no change in composition, and in clayey soils filtration is very slow or impossible.

The oxidation of the organic matter goes on most actively near the surface where there is a plentiful supply of air, and where the micro-organisms, which are the active agents of the change, are most abundant. Some distance below the surface, varying with the character of the ground, oxidation ceases, owing to absence of air. If we find a ground water with dissolved organic matter, or ammonia, or nitrites, we know that it must have been originally surface water in which, owing to unfavorable conditions, the organic matter has failed of complete oxidation. If this water is from great depths and free from oxygen it is evident that further purification

by oxidation cannot go on. In such a case the water may have a disagreeable odor, since the putrefaction of organic matter without oxygen, or with but a very limited supply, gives rise to offensive hydrogen compounds which are not noticeable when the supply of oxygen is abundant.

A water in which the organic matter has been completely oxidized in percolating through the soil has all of its nitrogen in the form of nitrates. The amount of nitrates in a ground water is, therefore, in some degree a measure of the nitrogenous matter which the water originally contained on the surface. The sources of the nitrates in the ground waters of uninhabited regions are mainly the ammonia in the rain and the ammonia resulting from the decay of vegetable and animal matters in the soil. But the ground water does not contain all of the nitrogen of this ammonia, since a part is directly or indirectly converted into new plant life. Vegetable matter, moreover, decays but slowly, a fact favorable to the absorption of nitrogen by plants rather than to its passage into the ground water as nitrates. The springs and wells which are distant from habitations are therefore, as we might expect, uniformly low in nitrates and occasionally, though rarely, they contain none at all. In the midst of a thickly settled region the ground water is almost always high in nitrates formed from the ammonia of house drainage. Hence we regard this determination of the nitrogen in the form of nitrates as one of great value as expressing the amount of previous pollution in the water.

It is impossible to give a dividing line between normal ground waters and those which have been polluted, based on their contents of nitrates alone, nor is there any evidence in the nitrates themselves to indicate whether they had a vegetable or animal origin. We have not, as yet, been able to discover as in the case of chlorine, a "normal" for nitrates in ground waters.

The difference between summer and winter in the nitrates of the ground waters of this State is scarcely noticeable. The average for the colder months is a little higher than for the warmer months, but the difference is insignificant.

In the following table is given the average composition for two years of some of the public water supplies of the State drawn from the ground, arranged in the order of the nitrates. The extremes, it will be noticed, are widely different, and one need not be in doubt as to the fact that those at the beginning of the list are normal, and that

those at the end contain the oxidized products of the organic matter of house drainage. In cases less pronounced, where there is doubt as to the significance of the nitrates, the amount of chlorine will enable us to decide; for, although the investigations in this direction are not yet complete, it is very probable that in this State the ground waters have the same normal of chlorine as the waters at the surface.

Some of the waters in this table are from wells or filter-galleries alongside of rivers, and the amount of nitrates in them may be influenced by the direct infiltration of river water without oxidation. In such cases the contents of nitrates do not fairly represent the ground water of the locality from which they are taken, and they show also higher contents of albuminoid ammonia than is usually the case in ground waters.

Analyses of Ground Waters, Averages.

[Parts per 100,000.]

	Number of Monthly Determinations.	Residue on Evaporation.	Ammonia.		Nitrogen as		Chlorine.
			Free.	Albuminoid.	Nitrates.	Nitrites.	
Pelham,	5	2.98	.0000	.0024	.0067	.0000	.10
Agawam,	7	3.14	.0005	.0015	.0080	.0000	.14
Mansfield,	4	2.73	.0000	.0014	.0083	.0000	.26
Uxbridge,	9	2.53	.0001	.0009	.0118	.0000	.17
Cohasset,	24	14.46	.0002	.0020	.0272	.0003	1.55
Brookline,	24	6.79	.0003	.0041	.0299	.0000	.53
Bridgewater,	11	4.20	.0011	.0016	.0312	.0001	.47
North Attleborough,	24	6.23	.0001	.0014	.0315	.0000	.51
Woburn,	24	11.78	.0011	.0029	.0358	.0000	2.39
Watertown,	22	6.98	.0002	.0035	.0540	.0000	.64
North Easton,	16	4.28	.0012	.0016	.0563	.0000	.42
Ayer,	17	5.16	.0004	.0017	.0626	.0001	.32
Hyde Park,	23	6.10	.0002	.0019	.0649	.0002	.75
Wellesley,	24	6.72	.0002	.0021	.0723	.0000	.46
Braintree,	12	7.14	.0006	.0045	.0948	.0003	.85
Kingston,	24	5.39	.0002	.0021	.0995	.0002	.83
Attleborough,	17	9.13	.0016	.0032	.1007	.0011	1.08
Revere,	24	22.55	.0001	.0019	.1408	.0024	3.41
Middleborough,	24	8.61	.0002	.0023	.1559	.0001	.96
Sharon,	12	7.99	.0001	.0007	.1884	.0001	.83

Analyses of Ground Waters, Averages — Concluded.

	Number of Monthly Determinations.	Residue on Evaporation.	Ammonia.		Nitrogen as		Chlorine.
			Free.	Albuminoid.	Nitrates.	Nitrites.	
Franklin,	12	8.77	.0001	.0015	.2230	.0002	.88
Grafton,	11	10.76	.0002	.0023	.2585	.0001	1.51
Dedham,	12	10.57	.0002	.0012	.2658	.0000	.95
Ware,	27	7.51	.0000	.0011	.2991	.0002	.63
Hopkinton,	11	14.67	.0001	.0017	.4095	.0001	1.88
Malden,	6	16.69	.0000	.0005	.4768	.0000	2.20
Swampscott,	24	25.01	.0013	.0032	.4786	.0003	3.28
Stoughton,	12	17.34	.0013	.0040	.8280	.0040	2.08

One cannot fail in examining this table to be struck with the remarkable completeness of the oxidation of the organic matter even in those waters which are high in nitrates. If we except the wells at Attleborough, Revere and Stoughton, the highest average free ammonia is .0012 and the highest nitrogen as nitrites .0003 parts per 100,000. And many of these waters are repeatedly found to be entirely free from ammonia and nitrites.

It is seldom, however, that organic nitrogen (as shown by the albuminoid ammonia) is entirely absent even in the best spring and well waters. This is also the case with the effluents from the purification of sewage by intermittent filtration. There is almost always a small amount of nitrogenous organic matter remaining even where the oxidation of the free ammonia is continuously and for long periods complete. The organic matter which exists in water under these circumstances must be of a nature that resists oxidation, and is not likely, therefore, to be of sanitary importance. In speaking, as we shall have frequent occasion to do, of the complete oxidation of the organic matter in water this small residue of albuminoid ammonia is ignored.

The nitrogen as nitrates in the water of Stoughton — the last on the list — far exceeds that of any of the other public water supplies of the State. But this amount is often exceeded in waters of wells in closely settled villages and towns where an amount of nitrogen as nitrates equal to 4 or 5 parts per 100,000 is sometimes met with.

The experiments on the purification of sewage by intermittent filtration which have been carried on at Lawrence, Mass., since the

fall of 1887, under the direction of Mr. Hiram F. Mills, the engineer member of the Board of Health, have added very largely to our knowledge of the conditions under which the oxidation of nitrogenous matter goes on in percolating through porous ground, and enable us to interpret more intelligently than we have hitherto been able the results of the analysis of ground waters. The reader is referred to the second volume of this report for a full description by Mr. Mills of this work at Lawrence. For our present purpose it will suffice to say that, when sewage filters slowly and intermittently through five feet of porous earth or sand, an effluent is obtained which is as free from organic matter, from ammonia and from nitrites, as many a natural spring water. To obtain this result, namely, that the nitrogen shall be completely converted into nitrates, it is necessary that the amount of sewage shall be adjusted to the capacity for purification of the filtering material. If too large an amount is applied, we have the evidence in the presence of the free and albuminoid ammonia and the nitrites of imperfect purification; in other words, the oxidizing agencies at work in the sand or soil have been overtaxed, and unoxidized nitrogen compounds appear in the filtered water.

Two facts stand out prominently among the results of these filtration experiments, namely, the short distance and the short time which suffice, under favorable conditions, in open porous soil for the complete oxidation of the organic matter and the ammonia of the sewage, and the definite and limited capacity, under constant conditions, which each soil has for purification. When a filter of this kind is working to its maximum capacity it is a very sensitive instrument. A very slight change of the conditions under which it is working will throw it out of adjustment, and an impure effluent will result. These facts have an important and obvious bearing on the use of water from wells which are exposed to sources of pollution.

The recorded and well authenticated cases of illness resulting from drinking ground waters are very numerous — far greater in number than those which can with certainty be referred to the use of waters of streams and lakes. Investigation of these cases shows almost invariably that the water of the well has received directly, or indirectly through the soil, the drainage from houses or cesspools. All wells in the vicinity of houses or barns are more or less exposed to such contamination, and it is a matter of the first

importance to know how far the information derived from a chemical analysis will enable us to say whether or not a well water can be used with safety. If we regarded the organic matter, or the products of its decay, as the sole cause of danger, then we should have in the determination of the nitrogen compounds a perfectly satisfactory means of deciding whether the water is in a fit condition to use. From this point of view we should reject all waters which contained free or albuminoid ammonia or nitrites, and accept only those which contained all the nitrogen in the form of nitrates.

But if the danger is to be ascribed to the presence of bacteria in the water, the results of a chemical analysis offer, as in the case of surface waters, only indirect evidence of its condition. We do not know yet what is the actual duration of life of specific disease germs in the soil, nor whether the conditions existing there are favorable for their growth and reproduction. We cannot, for instance, say that the disease germs which may have been present in sewage have lost their vitality when the organic matter in the sewage has been oxidized ; for, as far as we know, there is no necessary connection between the oxidizing action of the saprophytic bacteria and the life of the disease germs. It has been asserted as the result of experiment that great activity of the bacteria of decomposition is unfavorable for the life of disease germs, and that when these saprophytic bacteria have done their work of oxidation thoroughly they have also accomplished the destruction of the pathogenic bacteria. But the present state of our knowledge of the subject does not justify us in accepting this statement as final.

Where normal ground waters are not to be had, safety lies in time and distance from the source of pollution; the greater these are the greater the security from harm. Waters with very high nitrates are always to be regarded with suspicion even though they show for a long period a good purification; for high nitrates indicate a nearness of the source of pollution which is a constant menace to the purity of the water. Where the margin of safety is small a slight change of the existing conditions may result in a sudden and serious pollution of the well. Moreover, from the standpoint of bacterial contamination we cannot feel secure, even when the chemical purification is practically complete, if the source of contamination is near by.

There is plenty of evidence to show that waters with high nitrates and nitrites have been the cause of illness. Ekin and Mallet have

both called attention to the dangerous character of waters of this class. But we need to know more than this; namely, are the waters high in nitrates only dangerous when they contain also ammonia and nitrites, — that is to say when they are still undergoing change, when the bacteria of decomposition are still in full activity, — or may the danger still exist in waters of this class when the oxidizing processes are complete? Until bacteriological research, or, it may be, dearly-bought experience, brings with it the desired knowledge, the best we can do is to protect our wells from sources of pollution by making our factors of safety — time and distance — liberal.

We have assumed in this discussion of the purification of sewage or house drainage that it is exposed to air in porous soil near the surface. An entirely different condition of affairs exists when the polluting material enters the ground at considerable depth and soaks through earth where there is but little free oxygen. There can be but slow oxidation under these conditions, and long time and distance may be needed before oxidation is complete. Again, in the continuous filtration of ground water containing sewage oxidation goes on still more slowly. The pollution of the ground water under these conditions, namely, where sewage is filtered merely but not oxidized, is without doubt a source of serious and permanent danger.

The presence of organic matter, of ammonia, and even a bad odor in a well water, does not necessarily imply that the ground water of the region is polluted. The trouble may be in the well itself, which may contain organic matter which has dropped in from the surface — insects, worms and the like. In some wells the water at the bottom is stagnant. The water does not become bad on this account unless organic matter gets access to it, when putrefactive changes set in, owing to insufficient supply of dissolved oxygen, and the water becomes very foul. The remedy in such cases is very simple, namely, cleaning the well and protecting it carefully at the surface.

The water of artesian wells of great depth often contains a considerable quantity of free ammonia. The source of this ammonia is not certainly known in all cases. It has been referred in some localities to coal deposits. Of waters of this character we have no examples in Massachusetts.

At the beginning of this discussion we have spoken of the doubtful value of standards of purity of water based on the amount of

the nitrogen compounds which it contains. In the case of ground waters there is an *ideal* standard of purity which is at the same time not an impossible one, namely *complete freedom from unoxidized or partly oxidized compounds of nitrogen.* We do not know, as has been already explained, that a water which reaches this standard is safe if it at the same time contains much nitrogen completely oxidized, but we do know that as we depart from this standard we enter the region of known danger.

An attempt has been made, in the foregoing account of the origin and significance of the various substances which are determined in the chemical analysis of a water, to show that the interpretation should be based on the analysis as *a whole* and not on any single determination.

It has been a very general custom hitherto to set limits for each of the substances beyond which the water should be regarded as polluted or as unfit for drinking.

The application of these standards of purity made the interpretation of analyses a very simple matter but of very doubtful value. It has been thought worth while in the above discussion to show, in much detail, the one-sided and faulty deductions which may be made by giving too much weight to any one determination. Thus we have said that free ammonia is the evidence of decomposition of nitrogenous organic matter already begun, that it is the characteristic ingredient of sewage, and that it is one of the most reliable indications of sewage pollution in water. And yet under certain conditions we have seen that a sewage-polluted water may be free from ammonia and that a normal water may contain it abundantly.

Two lessons are to be learned from this (and they cannot be too strongly emphasized): namely, first, that a single determination in a chemical analysis of a water cannot tell us what the real condition of the water is; and, second, that one complete analysis tells us only what was the condition of the water when the sample was taken.

A single analysis, for instance, may be selected from the monthly examinations of Mystic Lake, which will show the water to be in a very good condition, with only the presence of the chlorine to indicate past pollution. Yet a glance at the series of analyses will show

that this condition is unusual, and that the water contains, for the greater part of the year, products of decomposition of organic matter in considerable amount. Such facts do not detract from the value of the chemical analysis of waters but show rather how easily a fatal mistake may be made by trusting to incomplete and infrequent analyses.

In the early part of this article there were given by way of illustration (page 541) several instances of normal and polluted waters to show how one might be easily misled by some single determinations. But in all these cases where the analyses are taken as a whole, and with a knowledge of the locality of the water, there is no uncertainty as to the interpretation. There are cases where one might be in doubt whether or not a water was polluted if the normal chlorine of the locality was unknown. There need be, however, no longer any uncertainty in this regard in Massachusetts, since the normals for all parts of the State are now fairly well determined. As regards pollution from sewage or house drainage in the waters of the State we may regard the evidence afforded by chemical analysis as complete and conclusive. This cannot be said of any other territory of like size in the country.

The subject will receive further illustration in a subsequent section of this report on the classification of the water supplies of the State.

REPORT UPON THE ORGANISMS,

EXCEPTING THE BACTERIA,

FOUND IN THE WATERS OF THE STATE.

JULY, 1887, to JUNE, 1889.

By G. H. PARKER, Biologist.

REPORT OF THE BIOLOGIST.

To Henry P. Walcott, M.D., *Chairman State Board of Health.*

Sir : — The following report presents an account of the organisms, excepting the bacteria, which have been found in the supplies of potable water in this Commonwealth. The report is based upon observations which have extended over a period of about two years. Investigations were begun July 1, 1887, and were continued under my direction till June 1, 1889. During the greater part of the first year the work consisted of special examinations, particularly with reference to the storage of ground waters. In March, 1888, the regular examination of water collected for chemical analysis was undertaken. This was continued till June, 1889; and the series of examinations thus brought together afforded, in the case of each water examined, a continuous set of observations for somewhat over a year. During the two years reported upon, the water supplied to Boston, Charlestown and Cambridge was examined monthly. Including the supplies of water from all sources, 3,442 examinations were made. The examinations during the first year were made for the most part by myself; during the second year they were made by Mr. C. B. Davenport and Mr. W. A. Setchell. Nearly all of the examinations were made in the laboratory for water analysis at the Massachusetts Institute of Technology, and I am under obligations to Dr. T. M. Drown and Mrs. R. H. Richards for many courtesies shown us.

The method by which the water from Boston, Charlestown and Cambridge was examined is described on page 587 of this report. The water collected for chemical analysis was examined for organisms in a somewhat different way. The material through which this water was filtered was the same quality of cotton cloth as that used in filtering the water from Boston, Charlestown and Cambridge, but the way in which the cloth was used was different in the two cases.

In preparing for an examination of water collected for analysis, a small piece of cloth was taken and firmly tied over the

stem of a common glass funnel. It was very important that the cloth should be bound as closely as possible to the open end of the stem, so that the water, when poured into the funnel, would filter through only that portion of the cloth which was directly in front of the end of the funnel. Having arranged the funnel in this manner, two hundred cubic centimeters of the water to be examined were poured into it; and, in order to facilitate the passage of the water through the cloth, the stem of the funnel was inserted into a suction bottle. Under a slight pressure the water passes through the cloth in a conveniently short time, and the particles suspended in it will be found, at the end of the operation, collected on a small circular area on the cloth. The cloth may now be removed from the funnel and inverted over a glass tube of a slightly larger calibre. The cloth should be so placed that the circular area of sediment on it will cover the end of the tube and that that face of the cloth on which the sediment is deposited will be outermost. With a sharp blast of air through the tube, the sediment, with a small amount of water, can be dislodged from the cloth and driven on a glass slide held close to the end of the tube.

The sediment thus collected on the slide is covered with a thin cover glass and examined under the microscope. Here the kinds of organisms present can be ascertained, as well as a rough approximation of their numbers. This method gives good results so far as a determination of the kinds of organisms is concerned. It allows the sediment of a considerable volume of water to be collected and examined in a pure state (free from the filtering material). From a quantitative standpoint the method at best yields only rough approximations. There are three principal causes of inexactness: first, a few organisms are known to pass through the cloth; second, it is usually impossible to remove *all* of the organisms from the cloth to the slide; and, third, it is difficult to distribute the sediment on the slide with such equality that accurate estimates of the number of organisms present can be made.

The majority of organisms which have been recorded are of microscopic size. At first sight it might appear that these organisms would be insignificant in proportion to their mass, and that more attention should have been devoted to the larger plants and animals. Very few cases have been observed, however, in which really serious trouble in water supplies can be referred directly to the growth of

large plants or animals; whereas, in many instances, waters with very objectionable qualities contain nothing to which these qualities can be attributed except microscopic organisms. Further, although the organisms here dealt with are of such small dimensions, the immense numbers in which they occur more than counterbalance their small size; and I am, therefore, of opinion that, of those organisms which cause objectionable qualities in water, the microscopic ones are the more important.

In dealing with these organisms, in the present report, the following topics have received attention: first, the relation of the odor in a water to the organisms which it contains; second, the kinds of organisms found in the waters supplied to Boston, Charlestown and Cambridge; third, the seasonal distribution of organisms; fourth, the distribution of organisms in waters variously situated; fifth, an attempt to outline a general scheme for the improvement of water made impure by organic growths; and, sixth, a brief account of fresh-water sponges and their relation to water supplies. In addition to these topics, which form the body of this report, a summary of the organisms which characterized the various waters examined will be found appended to the tables of chemical analyses in the reports on water supplies and rivers (see pages 1–516 of this volume).

I. — The Relation of Organisms and Odors in Natural Waters.

The odors which different waters possess are not always easily accounted for. They can arise from one or several causes. Pure water itself is odorless, consequently any odor which a water contains must be attributed to some foreign substance in it. The foreign substances which are in water are either organic or inorganic. The odors which most waters possess resemble those of organic rather than inorganic substances; and it is, therefore, fair to presume that the great majority of odors in natural waters are due to organic compounds. The organic compounds owe their origin to organisms, and are either the products of excretion from living organisms or the results of decomposition from dead ones.

From the relation which has been pointed out it might be inferred that odors and organisms should always accompany one another. This, however, is not necessarily true, for it is possible that in a given water an odor may be the only indication of organisms once present. Thus, for instance, any organisms attached to a firm sup-

port in a current of water may so taint the water that, even at a considerable distance from the source of contamination, the water may possess an odor derived from the organisms ; and this odor may be, moreover, the only evidence that the water has been in contact with an organism. It is further possible that a water might contain organisms and yet possess no odor. This condition could arise in one of two ways. Either the organisms in the water might give rise to no products of excretion or decomposition, or these products, if present, might be inodorous. It is thus evident that, although odors in waters are probably produced almost solely by organisms, it by no means follows that odors are always accompanied by organisms or organisms by odors.

Whether the odor in a water is caused by the excretions of organisms or by their decomposition is not easily determined. Possibly it may result from both causes. If the odor is due to excretions, one would rather expect that certain odors would be characteristic of certain organisms. On the other hand, if the odor is due to decomposition, the relation of the odor to particular organisms would probably not be so apparent.

In order to gain some light on these questions the observations on organisms and odors were carefully compared. The coincidences in this comparison were so few that one was not warranted in assigning a particular odor to a particular organism. On account of the diversity of organisms contained in the different waters the task of comparison was not an easy one, and its complexity may have influenced this rather unsatisfactory conclusion.

Although the relation between organisms and odors is apparently not a precise one, it is nevertheless not without its significance. The following tabulation will show something of its meaning. In the construction of this table five hundred representative observations were chosen from the examinations of the second year.* These were separated into two groups ; those in which there were no odors or very faint ones, and those in which the odors were pronounced. Depending upon the absence or presence of a significant number of organisms, these two groups were further subdivided. The number of waters which fell under the four sub-groups thus constituted are as follows : —

* The records of odors and organisms are more satisfactory for the second year than the first, consequently the comparisons were based mainly upon observations from that year.

I. Odors very faint or none.	
1. Organisms insignificant in number or none, ...	89
2. Organisms numerous, ...	227
II. Odors pronounced.	
1. Organisms insignificant in number or none, ...	0
2. Organisms numerous, ...	184
Total number of observations, ...	500

From this table it will be observed that, when the odors were pronounced, the organisms were always present in considerable numbers. On the other hand, when the odors were very faint or altogether absent, 89 cases were observed in which the organisms were practically absent and 227 cases in which they were represented in considerable numbers. The simultaneous absence of odors and organisms in a given water is what one would naturally expect. The presence of organisms and absence of odors is not at first sight a natural relation, although, as I have previously explained, it is not inconsistent with the idea that the odors are caused by the organisms. The fact that, in 227 cases in 500, odors were practically absent but organisms were present in considerable numbers, bears directly on the question of the origin of odors. If the odors were due to excretions, then one must explain the absence of odors in the 227 cases mentioned either by supposing that, at the time of collection and examination, these organisms produced no excretions or that their excretions were inodorous. The former supposition is not probable, because the physiological processes of nutrition, excretion, etc., in a plant go on with such regularity that interruptions such as this supposition demands are exceptional, if, indeed, they occur at all. The second supposition, namely, that the excretions were inodorous, is improbable, because, in one instance or another of the 227 cases cited, almost all of the important organisms which occur in potable water have been present. Consequently it cannot be maintained that the great number of organisms which these cases present is made up of only a few kinds of organisms the excretions of which might be inodorous. This fact is emphasized by the following table, in which are recorded the names of the more important organisms and the number of times when they were present in great numbers. The table is constructed from 100 representatives of the 227 examinations previously cited.

Generic Name of Organism.	Frequency with which the Organism was present in Abundance.
Anabæna,	1
Asterionella,	9
Chlorococcus,	6
Clathrocystis,	3
Cœlospherium,	2
Crenothrix,	4
Melosira,	1
Pediastrum,	1
Raphidium,	2
Scenedesmus,	6
Staurastrum,	2
Stephanodiscus,	6
Synedra,	17
Tabellaria,	8
Dinobryon,	5

The only organisms which are not mentioned in this enumeration, and which have been found to be of special significance in water supplies, are Oscillaria, Closterium, Spirogyra and Volvox. Excepting Spirogyra and Volvox, which are of rather rare occurrence in waters collected for examination, the remaining genera have been represented in sufficient numbers in other samples of practically odorless water to support the same conclusion as that drawn from the table. Thus Oscillaria has been twice present in large amounts in water from Jamaica Pond, and yet the samples have proved to be nearly odorless (samples Nos. 2750 and 2880, p. 63). Closterium was abundantly represented in water from Cohasset Reservoir, nevertheless the water was odorless (sample No. 2799, p. 106). In a similar way, water which contained great quantities of Cosmarium was without odor (sample No. 2918, p. 106). Spirogyra and Volvox have never been present in such quantities in odorless chemical samples of water but that it could be maintained that the absence of odor was due to the small number of organisms present.

Two conclusions can be drawn from these observations: first, *any* of the more important organisms can be abundantly represented in a water and yet that water can be odorless; and, second, the same kind of organisms in other instances appear to be the sole cause of

disagreeable odors. Any attempt to explain these odors as excretions from the organisms necessitates a belief in either a temporary cessation of the function of excretion or an alteration in the character of its products; two changes which, as I have previously stated, are decidedly improbable. If, then, the odors are not the products of excretion, they must result from the decomposition of dead organisms. That this conclusion is true is probable from the fact that the odors noticed in various waters are so generally similar, presenting by no means a diversity equal to the number of kinds of organisms.

II. — The Organisms found in the Water supplied to Boston, Charlestown and Cambridge.

The chief purpose of the following tables is to place upon record the kinds of organisms observed at different seasons in the service water of Boston, Charlestown and Cambridge.

The water supplied to these three places was examined monthly for two years beginning July 1, 1887. The samples for examination were collected from taps in the three places mentioned: that for Boston was taken at the tap in the basement of No. 13 Beacon Street; that for Charlestown from a tap in the shop of the water department at the corner of Tufts and Medford streets; that for Cambridge from a tap at Divinity Hall. These samples were obtained by straining about fifteen gallons of water through a cloth tied closely to the end of a faucet, and the sediment thus collected was removed to a glass slide and examined under the microscope. In order to record roughly the relative number of organisms present, the four following adjectives were used: "few," "several," "abundant" and "very abundant." The last three of these have been abbreviated to "sev.," "abd." and "v. abd.," and appear in this form in the tables. The usual significance of these adjectives is almost sufficient to indicate their meaning in connection with the number of organisms. "Few" is used where an organism was represented by a very small number of individuals. "Several" implies a greater number than "few" but not so many as "abundant." "Very abundant" is employed only when an organism was represented by an excessive number of individuals. Beside these adjectives the abbreviation "pr." is sometimes used; this signifies that the organism against which it stands was present, but no statement is made as to the number of individuals by which it was represented.

Of the following tables there are three sets, one for each of the

waters examined. In each set the organisms are arranged according to natural groups, the names of which, as well as those of the organisms themselves, are on the left-hand side of the tables. Opposite the name of each organism are two lines, one for each of the two years of observations. In order to facilitate comparison the corresponding months of the two years are arranged one above the other. The two years begin one in July, 1887, the other in July, 1888; hence the first and second years designated in the tables do not correspond to calendar years.

THE SERVICE WATER OF BOSTON.

[For an account of the sources of this water the reader is referred to the description of the Cochituate Works on page 29 of this volume.]

Algæ.

		July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1. CYANOPHYCEÆ.													
Anabæna,* .	First year, .	–	few	–	–	–	–	–	–	–	–	–	–
	Second year,	–	few	–	–	–	–	–	–	–	–	–	few
Aphanocapsa, .	First year, .	–	few	few	–	–	sev.	–	–	–	–	–	–
	Second year,	–	–	few	–	–	–	–	–	–	–	–	–
Clathrocystis,* .	First year, .	pr.	few	–	sev.	–	–	–	–	–	–	–	–
	Second year,	–	few	few	–	–	–	–	–	–	–	–	–
Cœlospherium,*	First year, .	–	few	–	–	pr.	abd.	few	few	–	–	–	–
	Second year,	few	few	few	few	–	–	–	–	–	–	–	–
Merismopedia, .	First year, .	–	–	few	–	–	–	few	–	–	–	–	–
	Second year,	–	–	–	–	–	–	–	–	–	–	–	–
Nostoc, . .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	–	–	–	–	–	–	–	–	few	–
Oscillaria, . .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	–	–	–	–	few	–	–	–	–	–
2. PALMELLACEÆ.													
Chlorococcus,* .	First year, .	pr.	abd.	–	–	–	–	–	–	–	sev.	few	–
	Second year,	v.abd	abd.	abd.	–	sev.	–	–	–	abd.	–	few	–
3. ZOOSPOREÆ.													
Cœlastrum, .	First year, .	–	–	–	–	pr.	–	–	–	–	–	–	–
	Second year,	–	–	–	–	–	–	few	few	–	–	–	–
Conferva, . .	First year, .	–	–	–	–	–	pr.	–	–	–	–	–	–
	Second year,	–	–	–	–	–	–	–	–	–	–	–	–
Ophiocytium, .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	few	–	–	–	–	–	–	–	–	–	–
Pediastrum,* .	First year, .	pr.	–	–	few	pr.	–	–	–	–	–	–	–
	Second year,	–	–	–	–	–	–	–	–	–	few	–	–
Polyedrium, .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	few	–	–	–	–	–	–	–	–	few
Raphidium,* .	First year, .	pr.	–	–	–	pr.	abd.	abd.	–	–	few	sev.	–
	Second year,	–	–	few	–	–	–	–	few	few	–	abd.	few
Scenedesmus,* .	First year, .	–	–	few	–	–	–	–	–	–	–	few	few
	Second year,	few	–	few	few	few	–	–	–	–	–	few	few
Tetraspora, .	First year, .	pr.	–	–	few	–	–	–	few	–	–	few	few
	Second year,	–	–	few	–	–	–	–	–	–	–	–	–

* Important.

THE SERVICE WATER OF BOSTON — Continued.

Algæ — Continued.

		July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
4. DESMIDIACEÆ.													
Arthodesmus, .	First year, .	–	few	few	few	pr.	abd.	–	–	–	–	–	–
	Second year,	–	–	–	–	–	–	–	–	–	–	–	–
Closterium,* .	First year, .	–	–	–	pr.	–	–	–	few	–	–	few	–
	Second year,	–	–	–	–	–	–	–	–	–	–	–	–
Cosmarium,* .	First year, .	pr.	–	–	–	–	–	–	–	–	–	–	–
	Second year,	few	–	–	–	–	–	–	–	–	–	few	–
Desmidium, .	First year, .	–	–	–	–	–	pr.	–	–	–	–	–	–
	Second year,	–	–	–	few	–	–	–	–	–	–	–	few
Sphærozosma, .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	few	–	–	–	–	–	–	–	few	–
Spirotænia, .	First year, .	–	–	–	–	–	–	–	few	–	–	–	–
	Second year,	–	–	–	–	–	–	–	–	–	–	–	–
Staurastrum,* .	First year, .	pr.	pr.	few	few	pr.	sev.	sev.	–	–	–	–	few
	Second year,	few	few	few	–	few	few	–	–	–	–	–	few
Staurogenia, .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	few	–	–	–	–	–	–	–	–	–
Xanthidium, .	First year, .	–	few	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	–	–	–	–	–	–	–	–	–	–
5. DIATOMACEÆ.													
Asterionella,* .	First year, .	–	–	–	–	pr.	abd.	v.abd	v.abd	abd.	abd.	v.abd	sev.
	Second year,	few	few	–	few	sev.	v.abd	v.abd	v.abd	v.abd	v.abd	v.abd	few
Denticula, . .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	few	–	–	–	–	–	–	–	–	–
Diatoma, . .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	–	–	–	–	–	–	–	–	few	–
Encyonema, .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	few	–	few	few	–	few	–	–	few	few
Epithemia, .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	–	few	–	–	–	–	–	–	–	–
Fragillaria, .	First year, .	–	–	–	–	–	–	–	few	–	–	–	–
	Second year,	–	–	–	–	–	–	–	–	–	–	–	–
Melosira,* . .	First year, .	–	–	sev.	sev.	–	–	–	sev.	sev.	abd.	abd.	few
	Second year,	few	sev.	sev.	few	abd.	abd.	abd.	v.abd	v.abd	v.abd	v.abd	sev.
Navicula, . .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	few	few	–	few	–	–	–	–	–	few	few
Nitzchia, . .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	–	–	–	–	–	few	–	–	–	–
Nitzchiella, .	First year, .	–	–	–	–	–	–	–	few	–	–	–	–
	Second year,	–	–	–	–	–	–	–	–	–	–	–	–
Pinnularia, .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	few	few	few	–	–	–	–	–	–	–
Surirella, . .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	–	–	few	few	–	–	–	–	–	–
Stauroneis, .	First year, .	–	–	–	–	–	–	–	–	–	–	few	–
	Second year,	–	few	few	–	–	–	–	–	–	–	–	–
Stephanodiscus,*	First year, .	pr.	abd.	abd.	abd.	–	abd.	abd.	v.abd	abd.	sev.	abd.	v.abd
	Second year,	sev.	few	few	few	sev.	sev.	abd.	v.abd	abd.	abd.	v.abd	v.abd
Synedra,* . .	First year, .	–	–	–	–	–	–	sev.	–	sev.	sev.	few	sev.
	Second year,	few	few	few	few	sev.	sev.	abd.	sev.	sev.	abd.	v.abd	sev.
Tabellaria,* .	First year, .	abd.	abd.	abd.	sev.	–	pr.	sev.	sev.	few	abd.	few	sev.
	Second year,	abd.	sev.	sev.	sev.	abd.	sev.	few	sev	few	abd.	abd.	sev.

* Important.

THE SERVICE WATER OF BOSTON — Concluded.

Algæ — Concluded.

		July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
6. ZYGNEMACEÆ.													
Spirogyra, .	First year, .	pr.	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	–	–	–	–	–	–	–	few	few	few
7. VOLVOCINEÆ.													
Eudorina, .	First year, .	pr.	pr.	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	few	–	–	–	–	–	–	–	–	–
Fungi.													
8. SCHIZOMYCETES.													
Beggiatoa, .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	–	–	–	few	–	–	–	–	–	–
Leptothrix, .	First year, .	–	–	–	–	–	–	–	sev.	–	–	–	–
	Second year,	–	–	few	–	–	–	–	–	–	–	–	few
Animals.													
9. PROTOZOA.													
Acineta, . .	First year, .	–	–	–	–	pr.	–	–	few	–	–	–	–
	Second year,	–	–	–	–	–	–	–	–	–	–	–	–
Amœba, . .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	–	–	–	–	–	–	–	–	–	few
Arcella, . .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	few	–	–	–	–	–	–	–	–	few
Ceratium, . .	First year, .	pr.	–	few	few	–	–	–	–	–	–	–	–
	Second year,	–	–	–	–	–	–	–	–	–	–	–	–
Difflugia, . .	First year, .	–	–	–	–	pr.	pr.	–	–	–	–	few	–
	Second year,	–	–	few	–	–	–	–	–	–	–	few	–
Dinobryon,* .	First year, .	–	few	–	–	pr.	–	few	–	sev.	pr.	sev.	–
	Second year,	sev.	–	few	–	few	–	sev.	sev.	abd.	v.abd	abd.	sev.
Hydromorum, .	First year, .	–	–	–	–	–	–	–	–	–	–	–	sev.
	Second year,	few	–	–	–	–	–	–	–	–	–	–	–
Peridinium,* .	First year, .	–	–	–	–	–	–	–	few	–	–	few	–
	Second year,	–	few	few	few	–	–	–	–	–	few	few	–
Trachelomonas,*	First year, .	–	pr.	few	few	–	pr.	–	sev.	sev.	abd.	–	–
	Second year,	–	few	few	few	few	–	abd.	abd.	sev.	sev.	sev.	few
10. SPONGIARIA.													
Sponge spicules,*	First year, .	abd.	sev.	sev.	few	pr.	pr.	–	few	–	–	–	few
	Second year,	few	few	few	few	few	–	few	–	few	–	–	few
11. ROTIFERA.													
Anurea, . .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	few	–	–	few	–	few	–	few	–	few	few
Rotifers,† . .	First year, .	abd.	few	–	–	pr.	pr.	few	–	–	–	few	–
	Second year,	–	few	–	–	few	–	–	–	–	–	–	–
12. ENTOMOSTRACA.													
Bosmina, . .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	few	–	–	–	–	–	–	–	–	–
Cyclops, . .	First year, .	–	–	–	few	–	–	–	–	–	–	few	–
	Second year,	–	–	–	–	–	–	few	–	few	–	–	–
Daphnia, . .	First year; .	–	–	–	–	–	pr.	–	–	–	–	–	–
	Second year,	–	–	–	–	–	–	–	–	–	few	–	–
Entomostraca,† .	First year, .	pr.	–	–	–	–	–	–	–	–	–	–	few
	Second year,	–	–	–	–	few	–	–	–	–	–	few	few

* Important. † Genera not determined.

The Service Water of Charlestown.

[For an account of the sources of this water the reader is referred to the description of the Mystic Works on page 35 of this volume.]

Algæ.

		July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1. Cyanophyceæ.													
Anabæna, . .	First year, .	–	–	–	–	–	–	–	–	–	–	–	few
	Second year,	few	–	–	–	–	–	–	–	–	–	–	–
Clathrocystis, .	First year, .	pr.	few	abd.	abd.	pr.	–	–	–	–	–	–	–
	Second year,	–	–	few	–	–	few	–	–	–	–	–	–
Cœlospherium, .	First year, .	–	few	–	–	pr.	pr.	–	–	–	–	–	–
	Second year,	–	–	–	–	–	–	–	–	–	–	–	–
Oscillaria, . .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	–	–	–	few	–	–	–	–	–	–
2. Palmellaceæ.													
Chlorococcus, .	First year, .	–	–	sev.	–	–	–	–	–	abd.	sev.	sev.	abd.
	Second year,	v.abd	–	few	few	–	few	–	sev.	abd.	–	v.abd	sev.
3. Zoosporeæ.													
Cœlastrum, .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	–	–	–	–	–	–	–	–	–	abd.
Conferva, . .	First year, .	–	–	–	–	–	–	few	abd.	–	–	–	–
	Second year,	–	–	–	–	–	–	–	–	–	–	–	–
Pandorina, . .	First year, .	–	–	–	–	–	pr.	–	–	–	–	–	–
	Second year,	–	–	–	–	–	–	–	–	–	–	–	–
Pediastrum, .	First year, .	pr.	few	few	few	pr.	pr.	–	–	–	–	–	–
	Second year,	–	–	few	few	–	few	few	–	–	–	–	few
Polyedrium, .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	few	few	few	few	few	–	–	–	–	–
Raphidium, .	First year, .	–	few	–	–	–	pr.	–	few	–	–	few	–
	Second year,	–	–	few	few	few	few	few	–	–	–	sev.	–
Scenedesmus, .	First year, .	pr.	pr.	–	sev.	pr.	pr.	sev.	few	–	–	sev.	few
	Second year,	few	few	sev.	abd.	v.abd	abd.	v.abd	abd.	abd.	abd.	v.abd	abd.
Tetraspora, .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	–	–	–	–	few	–	–	–	–	–
4. Desmidiaceæ.													
Closterium, .	First year, .	–	–	–	–	–	–	–	–	–	sev.	–	–
	Second year,	–	–	–	few	few	few	–	–	–	–	–	–
Cosmarium, .	First year, .	pr.	–	–	–	–	–	–	–	–	–	–	few
	Second year,	few	–	few	–	–	–	few	–	–	–	–	–
Euastrum, . .	First year, .	–	few	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	–	–	–	–	–	–	–	–	–	–
Spirotænia, .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	–	few	few	–	–	–	–	–	–	–
Staurastrum, .	First year, .	pr.	few	few	–	pr.	pr.	sev.	–	–	–	–	sev.
	Second year,	few	–	few	–	few	few	–	–	–	–	–	few
Staurogenia, .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	–	–	few	few	–	–	–	–	–	–
5. Diatomaceæ.													
Achnanthes, .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	–	–	few	–	few	–	–	–	–	–
Asterionella, .	First year, .	pr.	–	few	–	pr.	pr.	abd.	abd.	few	few	v.abd	v.abd
	Second year,	few	–	–	few	abd.	abd.	v.abd	v.abd	abd.	v.abd	v.abd	abd.
Cocconeis, . .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	–	few	–	–	–	–	–	–	–	–

THE SERVICE WATER OF CHARLESTOWN — Continued.

Algæ — Concluded.

		July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
5. DIATOMACEÆ-Con.													
Cocconema, .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	few	–	–	–	–	–	–	–	–	–
Encyonema, .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	–	–	few	few	–	–	–	few	–	–
Fragillaria, .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	–	–	–	–	–	–	–	–	–	sev.
Gomphonema, .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	few	–	few	–	–	–	–	–	–	–
Melosira, . .	First year, .	–	–	sev.	few	–	–	–	abd.	few	sev.	–	–
	Second year,	–	sev.	few	few	sev.	few	v.abd	v.abd	abd.	v.abd	abd.	abd.
Meridion, . .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	–	–	–	few	–	–	sev.	–	–	–
Navicula, . .	First year, .	–	–	–	–	–	–	–	few	–	–	–	–
	Second year,	–	–	–	few	–	few	–	sev.	–	–	sev.	–
Nitzchia, . .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	–	few	–	–	–	–	–	–	–	–
Nitzchiella, .	First year, .	–	–	–	–	–	–	–	few	–	–	–	–
	Second year,	–	–	–	–	–	–	–	–	–	–	–	–
Pinnularia, .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	few	–	–	few	–	–	–	–	–	–	–
Stauroneis, .	First year, .	–	–	–	–	–	–	–	–	–	–	few	–
	Second year,	–	–	–	–	–	–	–	–	–	–	–	–
Stephanodiscus,	First year, .	–	abd.	–	abd.	v.abd	abd.	–	–	–	–	few	sev.
	Second year,	few	–	few	few	sev.	few	–	–	–	–	sev.	abd.
Synedra, . .	First year, .	–	–	–	sev.	pr.	pr.	sev.	abd.	sev.	sev.	abd.	sev.
	Second year,	few	few	few	few	sev.	sev.	abd.	abd.	abd.	v.abd	v.abd	sev.
Tabellaria, . .	First year, .	–	–	–	–	pr.	pr.	sev.	pr.	–	abd.	sev.	sev.
	Second year,	–	few	–	few	few	few	sev.	abd.	sev.	v.abd	abd.	sev.
6. ZYGNEMACEÆ.													
Zygnema, . .	First year, .	–	–	–	–	–	pr.	–	–	–	–	–	–
	Second year,	–	–	–	–	–	–	–	–	–	–	–	–
7. VOLVOCINEÆ.													
Eudorina, . .	First year, .	pr.	few	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	–	–	–	–	–	–	–	–	–	–
Volvox, . .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	–	–	few	–	–	–	–	–	–	–

Fungi.

		July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
8. SCHIZOMYCETES.													
Crenothrix, .	First year, .	–	–	–	–	–	–	–	few	–	–	–	–
	Second year,	–	–	–	–	–	–	–	–	–	–	–	–
Leptothrix, .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	–	few	–	–	–	–	–	–	–	–

Animals.

		July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
9. PROTOZOA.													
Acineta, . .	First year, .	–	–	–	–	pr.	–	–	–	–	–	–	–
	Second year,	–	–	–	–	–	–	–	–	–	–	–	–

THE SERVICE WATER OF CHARLESTOWN — Concluded.

Animals — Concluded.

		July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
9. PROTOZOA — Con.													
Actinophrys, .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	few	–	–	–	–	–	–	–	–	–
Ceratium, . .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	few	–	–	–	–	–	–	–	–	–
Difflugia, . .	First year, .	pr.	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	–	–	pr.	–	sev.	few	–	.	–	–
Dinobryon, .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	few	–	few	–	few	few	few	–	–	–	–	sev.
Euglena, . .	First year, .	–	–	–	–	–	–	–	–	few	–	–	–
	Second year,	–	–	–	–	–	–	–	–	–	–	–	–
Hydromorum, .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	sev.	–	–	–	–	–	–	–	–	–	–	–
Monas, . .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	–	–	–	–	–	few	–	–	–	–
Peridinium, .	First year, .	pr.	abd.	–	–	–	pr.	–	–	–	few	–	–
	Second year,	–	abd.	sev.	sev.	sev.	–	–	few	–	–	–	sev.
Trachelomonas, .	First year, .	pr.	pr.	–	–	–	pr.	–	few	–	abd.	–	–
	Second year,	–	few	few	few	few	sev.	abd.	v.abd	abd.	v.abd	sev.	sev.
10. SPONGIARIA.													
Sponge spicules,	First year, .	pr.	pr.	few	few	pr.	–	sev.	few	–	–	–	–
	Second year,	few	–	few	few	few	few	–	–	few	–	–	–
11. NEMATODA.													
Anguillula, .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	few	–	–	–	–	–	–	–	–	–
12. ANNELIDA.													
Nais, . . .	First year, .	–	–	–	–	–	–	few	–	–	–	–	–
	Second year,	–	–	–	–	–	–	–	–	–	–	–	–
13. ROTIFERA.													
Anurea, . .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	few	few	few	few	–	few	–	few	–	few
Monostyla, .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	few	–	–	–	–	–	–	–	–	–
Rotifers,* . .	First year, .	–	–	few	–	pr.	pr.	few	few	–	few	–	few
	Second year,	few	–	–	–	–	–	–	–	–	–	–	–
14. ENTOMOSTRACA.													
Bosmina, . .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	few	–	few	few	–	–	–	–	–	–
Cyclops, . .	First year, .	pr.	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	–	–	–	–	few	–	–	–	–	–
Cypris, . .	First year, .	–	–	–	–	–	–	–	–	–	–	few	–
	Second year,	–	–	–	–	–	–	–	–	–	–	–	–
Daphnia, . .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	–	–	–	few	–	–	–	–	–	–
Entomostraca,* .	First year, .	–	–	–	–	–	pr.	few	few	–	–	–	few
	Second year,	few	–	–	–	–	–	–	few	–	–	–	–

* Genera not determined.

THE SERVICE WATER OF CAMBRIDGE.

[For an account of the sources of this water the reader is referred to the description of the water supply of Cambridge on page 86 of this volume.]

Algæ.

		July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
1. CYANOPHYCEÆ.													
Anabæna, . .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	few	few	–	–	–	–	–	–	–	–
Aphanocapsa, .	First year, .	–	–	few	few	–	–	–	–	–	–	–	–
	Second year,	–	–	–	–	few	–	–	–	–	–	–	–
Clathrocystis, .	First year, .	–	few	–	sev.	–	–	–	–	–	–	–	–
	Second year,	–	–	–	–	–	–	–	–	–	–	–	–
Cœlospherium, .	First year, .	–	–	–	–	few	few	–	–	–	–	–	–
	Second year,	–	–	–	few	few	pr.	–	–	–	–	–	–
Merismopedia, .	First year, .	–	–	–	–	–	–	few	–	–	–	–	–
	Second year,	–	–	–	–	–	few	–	–	–	–	–	–
2. PALMELLACEÆ.													
Chlorococcus, .	First year, .	abd.	abd.	sev.	–	–	pr.	abd.	abd.	abd.	sev.	sev.	sev.
	Second year,	abd.	sev.	few	few	few	few	few	–	–	–	–	–
3. ZOOSPOREÆ.													
Cœlastrum, .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	–	–	–	–	–	–	–	–	–	sev.
Conferva, . .	First year, .	–	–	–	–	–	pr.	few	–	–	–	–	–
	Second year,	–	–	–	–	–	–	–	–	–	–	–	–
Pandorina, . .	First year, .	–	–	–	–	few	abd.	–	few	–	–	–	–
	Second year,	–	–	–	–	–	–	few	–	–	–	–	–
Pediastrum, .	First year, .	pr.	–	–	–	–	pr.	few	–	–	–	–	–
	Second year,	–	–	few	few	–	few	–	–	–	–	–	–
Polyedrium, .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	few	–	–	–	–	–	–	–	–	–
Raphidium, .	First year, .	–	sev.	–	–	–	–	–	–	–	few	–	–
	Second year,	–	–	–	–	–	–	–	–	–	–	few	–
Scenedesmus, .	First year, .	–	–	sev.	few	abd.	–	sev.	–	few	few	few	–
	Second year,	–	–	few	few	few	few	sev.	–	–	–	sev.	few
Tetraspora, .	First year, .	pr.	–	–	–	–	pr.	–	–	–	–	–	–
	Second year,	–	–	–	–	–	–	few	–	–	–	–	–
4. DESMIDIACEÆ.													
Closterium, .	First year, .	–	–	–	–	–	–	–	few	–	–	–	–
	Second year,	–	few	few	few	few	few	few	few	–	–	–	–
Cosmarium, .	First year, .	–	–	–	–	–	–	–	–	–	sev.	few	–
	Second year,	–	–	–	–	–	–	–	–	–	–	abd.	–
Penium, . .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	–	–	–	–	–	few	–	–		–
Spirotænia, .	First year, .	–	–	–	–	–	–	few	few	few	–	–	–
	Second year,	–	–	few	few	few	few	few	few	–	–	–	–
Staurastrum, .	First year, .	–	–	few	–	–	pr.	–	–	–	–	–	–
	Second year,	–	–	–	–	–	–	–	–	–	–	–	–
Staurogenia, .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	–	–	few	sev.	abd.	sev.	few	few	–	few
5. DIATOMACEÆ.													
Amphora, . .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	–	–	few	–	–	–	–	–	–	–
Asterionella, .	First year, .	–	–	–	–	–	abd.	abd.	abd.	v.abd	v.abd	v.abd	abd
	Second year,	abd.	few	few	sev.	few	abd.	abd.	abd.	abd.	abd.	v.abd	–

THE SERVICE WATER OF CAMBRIDGE — Continued.

Algæ — Concluded.

		July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
5. DIATOMACEÆ-Con.													
Fragillaria, .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	–	–	–	–	–	–	–	–	–	few
Melosira, . .	First year, .	–	–	few	few	–	–	–	sev.	sev.	sev.	sev.	few
	Second year,	few	few	few	few	sev.	v.abd	v.abd	abd.	abd.	v.abd	v.abd	–
Meridion, . .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	–	–	–	few	–	–	–	–	–	–
Navicula, . .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	–	–	few	–	–	–	–	–	–	sev.
Stephanodiscus,	First year, .	pr.	abd.	v.abd	v.abd	pr.	abd.	abd.	abd.	sev.	abd.	v.abd	abd.
	Second year,	sev.	few	few	–	few	sev.	abd.	abd.	abd.	abd.	abd	abd.
Surirella, . .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	–	–	–	few	–	–	–	–	–	–
Synedra, . .	First year, .	–	–	–	–	–	–	–	–	–	–	few	–
	Second year,	–	few	–	–	–	sev.	abd.	abd.	abd.	abd.	sev.	sev.
Tabellaria, . .	First year, .	–	–	–	few	–	–	–	–	few	few	few	few
	Second year,	–	–	–	–	–	few	few	abd.	sev.	sev.	–	–
6. VOLVOCINEÆ.													
Eudorina, . .	First year, .	pr.	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	–	–	–	–	–	–	–	–	–	–
Volvox, . .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	–	–	–	few	–	–	–	–	few	–

Animals.

		July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
7. PROTOZOA.													
Actinophrys, .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	few	–	–	–	–	–	–	–	–	–
Ceratium, . .	First year, .	pr.	–	–	pr.	–	–	–	–	–	–	–	–
	Second year,	–	few	few	few	–	–	–	–	–	–	–	–
Dinobryon, .	First year, .	–	–	–	–	–	–	–	–	–	–	few	few
	Second year,	–	–	few	few	–	–	few	few	sev.	few	sev.	–
Hydromorum, .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	few	–	–	–	–	–	–	–	–	–	–	–
Peridinium, .	First year, .	–	–	–	–	–	–	–	–	–	–	few	few
	Second year,	–	–	–	–	–	–	few	–	sev.	few	few	–
Trachelomonas,	First year, .	–	–	–	few	few	pr.	–	few	sev.	–	–	–
	Second year,	–	few	few	few	few	few	few	–	v.abd	v.abd	–	few
Vorticella, . .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	few	–	–	–	–	–	–	–	–	–	–	–
8. SPONGIARIA.													
Sponge spicules,	First year, .	–	–	–	few	–	–	–	–	–	–	–	–
	Second year,	–	–	–	–	–	–	–	–	–	–	–	–
9. NEMATODA.													
Anguillula, .	First year, .	–	–	–	–	pr.	–	–	–	–	–	–	–
	Second year,	–	–	–	–	–	–	–	–	–	–	–	–
10. ROTIFERA.													
Anurea, . .	First year, .	–	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	few	few	–	few	–	–	few	few	few	–
Rotifers,* . .	First year, .	–	few	–	–	pr.	–	–	–	–	–	–	–
	Second year,	–	–	few	–	–	–	–	–	–	–	–	–

* Genera not determined.

THE SERVICE WATER OF CAMBRIDGE — Concluded.

Animals — Concluded.

		July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
11. ENTOMOSTRACA.													
Cyclops, . .	First year, .	–	–	few	–	–	–	–	–	–	–	–	–
	Second year,	–	–	–	–	–	–	–	–	–	–	–	–
Daphnia, . .	First year, .	sev.	–	–	–	–	–	–	–	–	–	–	–
	Second year,	–	–	–	–	–	–	–	–	–	–	–	–
Entomostraca,*	First year, .	pr.	pr.	few	–	pr.	–	–	few	–	–	–	–
	Second year,	–	–	–	–	few	–	–	–	–	–	–	few

* Genera not determined.

The preceding tables are of value not only as records of the organisms present in the particular water supplies examined, but, since they extend over a period of two years, they afford an opportunity of comparing the organisms of one year with those of another. One would naturally expect that the changes which the organisms show in one year would be reproduced in another; and, aside from some few deviations, this is on the whole true.

A glance at the tables will show that two kinds of organisms are to be recognized: first, those which are only occasionally and irregularly present, and which for the most part are represented only by small numbers of individuals; and, second, those which are much more regular in their occurrence and which are usually represented by many individuals.

The organisms which occur in great numbers are obviously the ones least likely to be overlooked, and, consequently, the best ones on which to base conclusions concerning the relation of one year with another. The more important of these are the nineteen genera which are marked with asterisks in the table for Boston. The record of these genera for the first year in the three water supplies examined fairly duplicates the record for the second year. The coincidence is by no means complete, but it is evident, and in some cases, as for instance those of Anabæna and Staurastrum in Boston, it is very nearly perfect. The only pronounced exceptions to the general rule of coincidence are the cases of Raphidium in Boston and Chlorococcus and Synedra in Cambridge. These organisms apparently followed different courses of development in the first year from what they did in the second.

The conclusion to be drawn from these observations is that, although some exceptional cases may be presented, as a rule the

more important genera reappear in a given year in much the same order as they appeared in the preceding year.

III. — The Seasonal Distribution of Organisms.

The following tables are intended to present, in a condensed form, a statement of the seasonal distribution of the more important organisms in potable water, and to serve possibly as a basis for predicting the nature of organic growths in waters not examined continuously for a whole year. The list of organisms includes the names of those only which may be called important either on account of their abundance or the frequency with which they have occurred. The organisms are arranged according to their natural groups.

Each genus of organisms is necessarily represented by living individuals throughout the whole year, yet at one season individuals may be much more numerous than at another. The tables of seasonal distribution are intended to show, in the case of the organisms enumerated, the frequency with which periods of greatest numbers have presented themselves during the year. These tables have been constructed from observations on such waters only as have been examined continuously for a whole year. In making the tables, complete sets of examinations were taken and the periods of greatest numbers for each organism were marked. From this record the tables were constructed. The method of interpreting a table can be made clear by an example. For this purpose Anabæna may be taken, the first organism in the following table. There were 56 complete sets of observations in which Anabæna was present. In these sets the periods of greatest numbers fell once in April, twice in May, seven times in June, and so on as shown in the table. The months when Anabæna was most frequently numerous were July and August. Admitting the year which this table represents to be typical, one would not expect to find Anabæna in great numbers during January, February or March. During the remainder of the year it might be looked for even in considerable numbers, although the period of its most frequent occurrence would be July and August.

With this explanation the following tables and brief notes will probably be easily understood.

I. — Algæ.

1. *Cyanophyceæ.* (*Blue-green Algæ.*)

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Anabæna, . .	0	0	0	1	2	7	13	13	11	6	2	1	56
Clathrocystis, .	0	1	0	1	0	1	3	14	9	4	4	0	37
Cœlospherium, .	0	1	0	0	0	4	8	5	8	2	0	0	28

These three genera were often numerous during summer and fall, especially in July, August and September.

2. *Palmellaceæ.*

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Chlorococcus, . .	0	3	5	4	3	11	34	32	11	1	3	2	109

3. *Zoosporeæ.*

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Pediastrum, . .	0	1	2	0	8	7	13	16	11	3	0	0	61
Raphidium, . .	1	1	1	2	10	8	12	13	10	4	0	0	62
Scenedesmus, .	2	1	1	0	10	8	23	23	13	7	3	1	92

These three genera seem to have two periods at which they were represented by excessive numbers; a short one in May and a longer one during July and August.

4. *Desmidiaceæ.*

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Closterium, . .	2	2	3	8	4	4	18	8	1	3	3	1	57
Cosmarium, . .	1	3	1	3	2	6	9	16	7	7	1	2	58
Staurastrum, .	0	1	1	5	2	7	23	11	10	4	1	0	65

These three genera were most frequently numerous during July and August.

5. *Diatomaceæ.*

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Asterionella, .	7	4	18	19	10	7	12	4	.2	7	7	10	107
Melosira, . .	7	6	10	16	10	3	12	8	5	11	9	2	99
Stephanodiscus, .	1	4	5	6	9	21	7	8	1	7	7	0	76
Synedra, . .	5	11	11	12	16	21	18	5	5	1	4	5	114
Tabellaria, . .	3	4	14	11	10	15	7	7	3	8	4	5	91

These genera of diatoms were very generally present throughout the year. They were more frequently numerous from March to July and during October than at other times.

ALGÆ — Concluded.

6. *Zygnemaceæ.*

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Spirogyra, . .	0	0	0	5	1	2	5	2	1	4	1	0	21

7. *Volvocineæ.*

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Volvox, . .	0	0	0	0	1	0	3	3	4	0	2	0	13

On account of the ease with which Volvox is destroyed by the motion of transportation, it is probable that the original observations on this organism are imperfect, and that, therefore, this table is somewhat defective.

II. — FUNGI.

8. *Schizomycetes.*

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Crenothrix,* .	1	0	0	2	2	18	45	3	2	3	1	1	78

This genus was distinctly characteristic of June and July.

* In the report of the biologist on pages 89 to 94 of the Nineteenth Annual Report of this Board, Crenothrix is referred to under the name of Hypheothrix.

III. — ANIMALS.

9. *Protozoa.*

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Dinobryon, . .	4	13	19	15	11	9	9	10	2	4	4	2	102
Peridinium, . .	5	9	13	6	5	3	23	20	8	1	2	2	97
Trachelomonas, .	4	7	13	6	5	5	15	11	16	7	6	3	98

These three genera were most frequently numerous during March, July and August.

10. *Spongiaria.*

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Sponge spicules, .	0	1	4	4	4	5	3	6	4	5	3	3	42

The presence of sponge spicules indicates the disintegration of sponges. This may or may not be accompanied by active growth on the part of the sponge. The disintegration is generally characteristic of the period from early spring to early winter.

ANIMALS — Concluded.

11. Rotifera.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Anurea, . .	2	1	3	3	3	8	7	12	14	4	0	0	57
Polyarthra, . .	0	0	1	0	1	1	1	3	4	2	2	0	15
Rotifers,* . .	1	4	1	2	5	6	10	2	4	3	1	1	40

The Rotifers were rather characteristic of summer and autumn.

12. Entomostraca.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Bosmina, . .	1	1	0	0	1	0	2	4	3	3	2	2	19
Cyclops, . .	1	1	3	2	6	10	6	9	12	2	0	3	55
Daphnia, . .	0	0	1	0	4	7	8	3	4	4	0	1	32
Diaptomus, . .	0	0	0	0	0	0	0	1	2	2	2	0	7
Entomostraca,* .	4	4	3	2	1	7	7	7	2	2	1	1	41

The Entomostraca were somewhat more frequently present during summer and autumn than during the remainder of the year.

A Table showing the Months when Particular Groups of Organisms were most frequently represented by Excessive Numbers.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Cyanophyceæ, . .	-	-	-	-	-	-	×	×	×	-	-	-
Palmellaceæ (1 genus), .	-	-	-	-	-	-	×	-	-	-	-	-
Zoosporeæ, . . .	-	-	-	-	×	-	×	×	-	-	-	-
Desmidiaceæ, . . .	-	-	-	-	-	-	×	×	-	-	-	-
Diatomaceæ, . . .	-	-	×	×	×	×	×	-	-	×	-	-
Zygnemaceæ (1 genus), .	-	-	-	×	-	-	×	-	-	×	-	-
Volvocineæ (1 genus), .	-	-	-	-	-	-	-	-	×	-	-	-
Schizomycetes (1 genus),	-	-	-	-	-	×	×	-	-	-	-	-
Protozoa, . . .	-	-	×	-	-	-	×	×	-	-	-	-
Spongiaria (spicules), .	-	-	-	-	-	-	-	×	-	-	-	-
Rotifera, ...	-	-	-	-	-	-	-	-	×	-	-	-
Entomostraca, . .	-	-	-	-	-	×	×	×	×	-	-	-

* Genera not determined.

IV. — The Distribution of Organisms in Waters variously situated.

The following tables are intended to show the distribution of organisms as determined by the conditions with which they are surrounded. In making the tables it was necessary to adopt some classification for the different kinds of water; and, although the groups herein presented are more or less arbitrary, it is hoped that by the use of the following definitions clearness can be retained.

Two principal divisions of natural potable waters are generally recognized: ground waters and surface waters. Ground waters are those which are obtained from some distance below the surface of the soil, and which presumably have been in that position for some time. Surface waters are those which occur exposed on the surface of the soil. There can be of course no sharp line drawn between these two kinds of water. Ground waters shade imperceptibly into surface waters.

Ground waters have been divided into four sub-groups as follows: first, waters derived from driven wells or deep filter galleries; second, waters obtained from natural springs as they issue from the earth; third, ground waters from either of these sources stored in reservoirs or tanks from which the light is excluded; and, fourth, ground waters stored in positions exposed to the light. This last group can be said to represent a ground water which is being converted into a surface water.

Depending upon the positions in which the surface waters occur, nine groups have been distinguished. They are as follows: first, surface waters in natural ponds, lakes, etc.; second, waters in artificial ponds, etc. The difference between artificial and natural ponds is made to depend upon the past and present water level of the ponds. If, in the preparation of a pond for a water supply, the water level is not materially raised, the pond would be classed as a natural pond. If, on the other hand, the water level is so elevated that much land originally uncovered with water becomes covered, the pond would be called artificial. Of course artificial ponds can be made by damming streams as well as by raising the level of natural ponds. This group includes many storage reservoirs. In each of the four following groups surface water obtained from various sources is stored in open reservoirs or tanks. As places for the temporary storage of water these reservoirs can usually be

distinguished from ponds either artificial or natural, and from the majority of storage reservoirs, by the fact that their bottoms have been especially prepared for the reception of the water. Of course, in the case of most artificial ponds, more or less care is taken in the removal of brush and loam from the land before it is flooded ; but this preparation is by no means so extensive as that involved in the construction of a distributing reservoir. Beside this characteristic the reservoirs included in these four groups have usually been built in places not previously occupied by water, as for instance hill tops, whereas artificial ponds and the majority of storage reservoirs occupy the position of former ponds or water courses. The source of the water has been made the distinguishing feature in the four groups. The first of these includes water stored in reservoirs or tanks and obtained from natural ponds ; in the second group the water is obtained from artificial ponds ; in the third, from rivers or brooks ; and, in the fourth, the reservoir or tank is filled with partially filtered surface water. The three remaining kinds of surface water are water from rivers, water from brooks and partially filtered surface water taken directly from the filters. This last kind might be said to represent a surface water which by filtration was being converted into a ground water, but in which the method of filtering employed was too imperfect to accomplish this conversion completely or to remove many of the smaller algæ. The waters consequently are described as *partially* filtered.

Of the following tables one is devoted to the representatives of each of the more important groups of organisms. The kinds of water as previously defined are enumerated on the left-hand side of the table. The column of figures to the extreme right represents the total number of observations made on particular kinds of water ; the remaining columns show the number of times a given organism was present in a given kind of water. The generic names of the organisms are found at the head of their appropriate columns. In addition to these general tables special tables have been constructed for some of the groups. These are designed to illustrate particular facts in the distribution of the organisms not easily seen in the general tables. Both kinds of tables are arranged according to the natural classification of the groups of organisms for which they were constructed.

I. — ALGÆ.

1. Cyanophyceæ.

	Kinds of Water.	Anabæna.	Clathrocystis.	Cœlospherium.	Total Number of Observations.
Ground Waters.	Driven wells, deep filter galleries, etc.,	1	1	1	323
	Springs,	0	0	0	24
	Closed reservoirs,	1	0	0	34
	Open reservoirs,	1	0	1	163
Surface Waters.	Natural ponds,	55	44	23	386
	Artificial ponds,	42	57	11	376
	Open reservoirs:				
	from natural ponds,	1	0	1	14
	from artificial ponds,	17	16	7	112
	from rivers and brooks,	23	21	2	190
	from partially filtered surface water,	2	0	0	57
	Rivers,	21	14	10	554
	Brooks,	2	2	0	91
	Partially filtered surface water,	1	2	0	51

In *moving* surface waters,	23	16	10	645
In *standing* surface waters,	140	138	44	1145
In *moving* surface waters,	3.5%	2.5%	1.5%	100%
In *standing* surface waters,	12.0%	12.0%	3.8%	100%
In open reservoirs filled from rivers and brooks,	12.1%	11.0%	1.0%	100%

The Cyanophyceæ, as represented by the three genera named in this table, are generally absent from ground waters even when these are contained in open reservoirs. On the other hand, they occur in surface waters in almost all situations. As the smaller table shows, they are more abundant in standing surface water than in that which is in motion. This, in all probability, is due simply to the motion of the water, which when violent is known to destroy these delicate plants, although the previous history of the water (whether it comes directly from a pond or is collected from a broad watershed or some other source) has unquestionably more or less influence in determining the character and amount of the organisms contained. That the difference between the blue-green algæ of moving and quiet water is not due to a difference in the qualities of the water is evident from the fact that, when water from rivers or brooks is stored in open reservoirs, the growth of these plants, excepting Cœlospherium, is almost as general as in the average of other standing surface water.

ALGÆ — Continued.

2. Palmellaceæ.

	Kinds of Water.	Chlorococcus.	Total Number of Observations.
Ground Waters.	Driven wells, deep filter galleries, etc.,	12	323
	Springs,	1	24
	Closed reservoirs,	1	34
	Open reservoirs,	55	163
Surface Waters.	Natural ponds,	118	386
	Artificial ponds,	141	376
	Open reservoirs:		
	from natural ponds,	9	14
	from artificial ponds,	54	112
	from rivers and brooks,	53	190
	from partially filtered surface water,	25	57
	Rivers,	178	554
	Brooks,	15	91
	Partially filtered surface water,	6	51

Excepting in the open reservoirs, where it is frequently present, Chlorococcus occurs only occasionally in ground waters. It is generally present in surface waters, occurring in about 35 per cent. of the standing waters and 30 per cent. of those in motion.

3. Zoosporeæ.

	Kinds of Water.	Pediastrum.	Raphidium.	Scenedesmus.	Total Number of Observations.
Ground Waters.	Driven wells, deep filter galleries, etc.,	0	2	4	323
	Springs,	0	0	1	24
	Closed reservoirs,	0	0	0	34
	Open reservoirs,	4	18	51	163
Surface Waters.	Natural ponds,	19	21	61	386
	Artificial ponds,	44	48	109	376
	Open reservoirs:				
	from natural ponds,	0	4	2	14
	from artificial ponds,	9	11	30	112
	from rivers and brooks,	38	15	55	190
	from partially filtered surface water,	11	15	20	57
	Rivers,	55	58	133	554
	Brooks,	2	4	12	91
	Partially filtered surface water,	7	7	26	51

The Zoosporeæ, as represented by the three genera in this table, occur in ground waters when stored in open reservoirs and in surface waters generally. They are present somewhat more frequently in standing than in moving water. Of the three genera mentioned, Pediastrum occurs less frequently and Scenedesmus most frequently.

ALGÆ — Continued.

4. Desmidiaceæ.

	Kinds of Water.	Closterium.	Cosmarium.	Staurastrum.	Total Number of Observations.
Ground Waters.	Driven wells, deep filter galleries, etc.,	1	0	1	323
	Springs,	1	0	0	24
	Closed reservoirs,	2	0	1	34
	Open reservoirs,	13	16	5	163
Surface Waters.	Natural ponds,	22	15	53	386
	Artificial ponds,	38	36	106	376
	Open reservoirs:				
	from natural ponds,	1	1	3	14
	from artificial ponds,	8	7	26	112
	from rivers and brooks,	18	17	34	190
	from partially filtered surface water,	3	2	0	57
	Rivers,	56	53	50	554
	Brooks,	12	12	8	91
	Partially filtered surface water,	2	2	0	51

These Desmids occur principally in open reservoirs of ground waters and in surface waters.

5. Diatomaceæ.

	Kinds of Water.	Asterionella.	Melosira.	Stephanodiscus.	Synedra.	Tabellaria.	Total Number of Observations.
Ground Waters.	Driven wells, deep filter galleries, etc.,	40	26	9	29	14	323
	Springs,	3	4	0	5	1	24
	Closed reservoirs,	2	2	0	3	1	34
	Open reservoirs,	50	16	11	88	14	163
Surface Waters.	Natural ponds,	174	168	163	184	165	386
	Artificial ponds,	153	147	64	228	179	376
	Open reservoirs:						
	from natural ponds,	11	5	5	11	4	14
	from artificial ponds,	77	72	60	66	69	112
	from rivers and brooks,	84	89	25	106	91	190
	from partially filtered surface water,	32	17	3	47	7	57
	Rivers,	178	229	54	452	287	554
	Brooks,	8	27	19	66	23	91
	Partially filtered surface water,	8	12	2	17	9	51
In *standing* surface water,		47%	44%	28%	57%	46%	100%
In *moving* surface water,		28%	39%	11%	80%	48%	100%

The genera of Diatoms enumerated in this table occur sparingly in the first three kinds of ground waters; they are generally abundant in ground water stored in open reservoirs and in all surface waters. Synedra and Tabellaria are more generally characteristic of rivers and brooks than of standing surface water; the other genera occur more frequently in standing water.

ALGÆ — Concluded.

6. Zygnemaceæ and 7. Volvocineæ.

	Kinds of Water.	Spirogyra.	Volvox.	Total Number of Observations.
Ground Waters.	Driven wells, deep filter galleries, etc.,	1	0	323
	Springs,	0	0	24
	Closed reservoirs,	0	0	34
	Open reservoirs,	2	6	163
Surface Waters.	Natural ponds,	9	8	386
	Artificial ponds,	7	3	376
	Open reservoirs:			
	from natural ponds,	0	0	14
	from artificial ponds,	2	2	112
	from rivers and brooks,	4	3	190
	from partially filtered surface water,	4	0	57
	Rivers,	17	3	554
	Brooks,	2	0	91
	Partially filtered surface water,	7	0	51

II. — Fungi.

8. Schizomycetes.

	Kinds of Water.	Crenothrix.	Total Number of Observations.
Ground Waters.	Driven wells, deep filter galleries, etc.,	39	323
	Springs,	3	24
	Closed reservoirs,	9	34
	Open reservoirs,	2	163
Surface Waters.	Natural ponds,	14	386
	Artificial ponds,	26	376
	Open reservoirs:		
	from natural ponds,	0	14
	from artificial ponds,	3	112
	from rivers and brooks,	12	190
	from partially filtered surface water,	0	57
	Rivers,	67	554
	Brooks,	10	91
	Partially filtered surface water,	21	51

Crenothrix occurred in a moderate number of instances in all kinds of water. It was most frequently present in partially filtered surface water.

III. — Animals.

9. *Protozoa.*

	Kinds of Water.	Dinobryon.	Peridinium.	Trachelomonas.	Total Number of Observations.
Ground Waters.	Driven wells, deep filter galleries, etc.,	12	6	9	323
	Springs,	0	0	0	24
	Closed reservoirs,	0	0	0	34
	Open reservoirs,	31	26	31	163
Surface Waters.	Natural ponds,	173	97	87	386
	Artificial ponds,	135	125	104	376
	Open reservoirs:				
	from natural ponds,	11	3	0	14
	from artificial ponds,	59	30	42	112
	from rivers and brooks,	88	64	44	190
	from partially filtered surface water,	12	10	15	57
	Rivers,	204	108	104	554
	Brooks,	19	13	13	91
	Partially filtered surface water,	4	4	6	51

Each of the three genera of Protozoa mentioned in this table occurred in a few samples of the water from driven wells, etc. Excepting the water of open reservoirs, the other kinds of ground water showed no trace of these organisms. The Protozoa occur very frequently in open reservoirs filled with ground water and in all kinds of surface water.

10. *Spongiaria.*

	Kinds of Water.	Sponge Spicules.	Total Number of Observations.
Ground Waters.	Driven wells, deep filter galleries, etc.,	2	323
	Springs,	0	24
	Closed reservoirs,	0	34
	Open reservoirs,	1	163
Surface Waters.	Natural ponds,	15	386
	Artificial ponds,	15	376
	Open reservoirs:		
	from natural ponds,	0	14
	from artificial ponds,	6	112
	from rivers and brooks,	5	190
	from partially filtered surface water,	2	57
	Rivers,	36	554
	Brooks,	9	91
	Partially filtered surface water,	0	15

Judging from the presence of spicules, the growth of sponges is more general in surface than in ground waters. In running surface water, spicules were present in 6.9 per cent. of the samples examined; in standing water they were observed in only about 3.7 per cent. of the examinations. Their more frequent occurrence in running water may be due to the fact that the spicules would probably settle to the bottom less easily in running than in quiet water. Nevertheless, for reasons which will be given in section VI. of my report, it is probable that the more frequent occurrence of spicules in running water indicates a more frequent growth of sponge in that position.

ANIMALS — Concluded.

11. Rotifera.

	Kinds of Water.	Anurea.	Polyarthra.	Rotifers.*	Total Number of Observations.
Ground Waters.	Driven wells, deep filter galleries, etc.,	0	0	0	323
	Springs,	0	0	0	24
	Closed reservoirs,	0	0	0	34
	Open reservoirs,	9	1	9	163
Surface Waters.	Natural ponds,	41	8	22	386
	Artificial ponds,	47	6	15	376
	Open reservoirs:				
	from natural ponds,	1	0	1	14
	from artificial ponds,	9	2	9	112
	from rivers and brooks,	14	5	6	190
	from partially filtered surface water,	0	0	3	57
	Rivers,	21	3	11	554
	Brooks,	5	0	1	91
	Partially filtered surface water,	0	0	0	51

12. Entomostraca.

	Kinds of Water.	Bosmina.	Cyclops.	Daphnia.	Diapterus.	Entomostraca.*	Total Number of Observations.
Ground Waters.	Driven wells, deep filter galleries, etc.,	0	1	0	0	2	323
	Springs,	0	0	0	0	0	24
	Closed reservoirs,	0	0	0	0	0	34
	Open reservoirs,	2	5	6	2	10	163
Surface Waters.	Natural ponds,	12	43	16	6	34	386
	Artificial ponds,	9	39	13	2	18	376
	Open reservoirs:						
	from natural ponds,	0	3	2	0	1	14
	from artificial ponds,	0	11	3	1	6	112
	from rivers and brooks,	4	11	6	0	5	190
	from partially filtered surface water,	0	1	0	0	0	57
	Rivers,	4	12	8	0	5	554
	Brooks,	0	4	0	0	0	91
	Partially filtered surface water,	0	3	1	0	2	51

The Rotifera and Entomostraca occur for the most part in open reservoirs filled with ground water and in all kinds of surface water.

* Genera not determined.

V.—The Purification of Water rendered Impure by Organic Growths.

The importance that organisms possess in their relation to the disagreeable odors and tastes in natural waters has already been pointed out, and the desirability of being able to check their growth must, therefore, be apparent. The following account cannot pretend to do more than outline what appear at present to be the most promising methods of attaining this end, and it must remain for future experimentation to determine whether or not these methods are practicable.

That particular organisms are present in certain waters and absent from others is a fact which requires no demonstration. If the economy of these organisms were fully understood and the influence of their surroundings completely appreciated, it is probable that their presence or absence from a given water could be fully accounted for. Once having sufficient knowledge to take this step it is also probable that means might be devised by which the growth of these organisms in other waters might be effectually checked. Unfortunately a knowledge of organisms complete enough for this purpose is not at present to be had, and the best that can be done is to endeavor to gain some clew to the more important influences which determine the presence or absence of those organisms with which we have to deal.

In order to gain some idea of the nature of these influences it will be necessary to return to the tables in the preceding section. It will be recalled that the organisms mentioned in these tables were grouped under three chief heads: Algæ, Fungi and Animals. By comparing the various tables it will be observed that the algæ, although generally present in surface waters, were found, with very few exceptions, in only those ground waters which were stored in open reservoirs. Crenothrix, the only representative of the fungi, was present in all classes of water. The distribution of the animals is essentially the same as that of the algæ. If, now, the kinds of water be compared, it will be seen that the algæ were absent for the most part from the water of driven wells, filter galleries, springs and closed reservoirs. These are situations in which the water is either not open to the light or is newly exposed to it. In all other situations described, the water is open either to direct or diffused sunlight. The algæ then are present in waters exposed to the

light and absent from waters inaccessible to it. It has long been known that sunlight is essential to the continued life of not only the algæ but all green plants. It is, therefore, not surprising that the algæ occur only in lighted situations. To them light is an essential element in the production of their food. Hence the absence of light determines the absence of algæ.

With a view of determining to what extent food and its production should be regarded as a controlling factor in the growth of organisms, it will be necessary to examine somewhat more closely the character of the food of different organisms. The living substance of all organisms is composed principally of four chemical elements united in very complex compounds. These elements are carbon, hydrogen, oxygen and nitrogen. In addition to these there are several others which, although constant in their occurrence, are present only in very small quantities. The wear and tear in the body of an organism necessitates the destruction of many of the compounds in its substance, and as a result there is a continual escape from its body of material including the four elements already mentioned. In order to replace this loss the organism necessarily appropriates new material, which must contain at least a fair proportion of the four elements named. This constitutes its food.

In the case of green plants — and this statement of course includes the algæ — the source of the four principal constituents of the food has been carefully ascertained by experiment. It is known that the carbon is usually derived from the carbon dioxide of the surrounding atmosphere or water; that the hydrogen is obtained by decomposing water which consists of a union of hydrogen and oxygen, and that the oxygen can be taken from either the carbon dioxide, the water or both. It is equally well known that the uncombined nitrogen of the air is practically inaccessible to green plants, and that their nitrogen is derived from the decomposition of compounds of nitrogen, such as ammonia or some nitrate. The simplest diet, then, on which a green plant might subsist, considering only the chief elements, is carbon dioxide, water and some nitrate or other compound of nitrogen.

If a green plant were presented with the three compounds named and no other assistance were given it, it would be entirely unable to reorganize these compounds for the use of its body. In order that a reorganization should take place it is necessary that a supply of energy be at hand by which the requisite chemical changes can

be effected. This supply of energy the green plant finds in the sunlight ; hence the vital importance of this factor to the plant.

The changes which have thus far been described are accomplished by green plants only. The color which these plants possess is due to chlorophyl, a green coloring matter produced in their tissues. Chlorophyl, as might be suspected, is intimately connected with the reorganization of the food, and in fact is essential to it. From these various statements the general conclusion may be drawn that all plants possessing chlorophyl, when supplied with the necessary simple compounds and in the presence of sunlight, have the power of organizing their own food. All other organisms — i. e., plants without chlorophyl (fungi), and animals — are without this power. Plants without chlorophyl, and animals, obtain their food already organized either directly from green plants or indirectly through other organisms, which in turn depend for their food upon green plants. Thus all animals or plants not capable of organizing their own food are dependent either directly or indirectly upon green plants for their nourishment.

Having thus shown the relation which organisms with and without chlorophyl bear to their food, it would be well to return to the tables previously cited and examine them more critically to determine whether in their detail any exceptional features are presented.

The presence of algæ in almost all instances of water exposed to the light is a perfectly natural condition. Their presence, even in small numbers, in situations described as dark is not what might be anticipated. This fact, which is evident from an inspection of the tables, is not, however, inconsistent with the general statement already advanced ; for in many instances wells, and especially filter galleries, described as dark have proven on examination to be accessible to the light either through defective roofs or walls or by ventilating shafts, etc. The amount of light admitted in these cases is of course very small, but nevertheless it is often enough to render possible a limited growth of green algæ. An illustration of the growth of algæ under these circumstances is afforded in the case of the water supply of Dedham. The well of this water supply was described as covered to exclude the light (see page 114), nevertheless the water from the well had continually present in it a small number of diatoms. On carefully inspecting the well the roof was found to be slightly defective, so that on clear days a small beam of sunlight fell on the water and north wall. Scrapings from this

wall contained a few diatoms; scrapings from the south wall on which no light fell contained no green algæ. The few diatoms found in the water pumped from the well doubtless came from the growth established on the north wall. The kinds of algæ which inhabit these partially lighted situations are not very numerous; Chlorococcus, Asterionella, Melosira, Synedra and Tabellaria are the principal genera. Although I am of opinion that the majority of records of green algæ in situations described as dark are to be interpreted as cases in which perfect darkness is not attained, as at Dedham, still it is possible that some of these cases may be the result of accidents in collection or examination. Thus the rinsing of apparatus after the examination of one water may have been imperfectly done in some cases, so that a few organisms may have been introduced into the second water examined. Such accidents, however, must have been exceptional.

Since the animals are dependent upon the algæ for food, it is natural that their presence should coincide very nearly with that of the algæ.

Crenothrix, the only fungus tabulated, is present in nearly all classes of water. There are many reasons for believing that this plant does not possess the power of organizing its food. Nevertheless, it occurs in positions where there are practically no algæ. The character of its food must, therefore, be somewhat different from that of animals with which it has been previously associated. Animals eat either whole plants or animals or fragments of these; Crenothrix thrives in positions where not even fragments are to be obtained. It is probable that, like many of its relations, Crenothrix subsists upon the small amount of organic matter dissolved in many waters. In other words, it is capable of deriving all of its necessary nourishment from very dilute infusions. Such being the case, one would expect to find it most abundant in water rich in products from decomposing organisms. As a matter of fact, it occurs most frequently in surface water which has been incompletely filtered. In the filtration of surface water great numbers of organisms are lodged on or in the filtering material; the subsequent death and decomposition of these would contribute materially to the amount of organic substance dissolved in the water; hence this water would be especially favorable for the growth of Crenothrix.

The relations which the different kinds of organisms sustain to their food and the influence which food exerts upon them in deter-

mining their absence or presence have now been sufficiently dwelt upon. It remains only to point out how these facts can be of service in controlling the growth of organisms in water.

In the case of ground supplies, either driven wells, filter galleries or springs, the water is usually obtainable free from organic growths. In order that it should be preserved in this state it is only necessary that no opportunity should be given for the growth of organisms. If the water is not exposed to the light, for reasons already given, the growth of algæ would be prevented. If the growth of algæ is prevented, it is impossible for animals to thrive, for they are dependent upon the algæ for their food. Thus both algæ and animals could be excluded. The growth of a fungus, as for instance Crenothrix, is not so easily dealt with; but any water which at its source does not contain enough dissolved organic matter to support a growth of Crenothrix or allied organisms, and which receives no further additions of organic material in its passage from its source to the consumer, ought to be delivered as free from fungous growth as when it was first taken from the ground. Thus, in the case of a ground water free from organic matter, contamination from the growth of algæ, fungi or animals can be prevented by the exclusion of light.

The position to be taken in dealing with pure ground waters is simply a defensive one — avoid the light. To furnish surface waters free from organisms the offensive position must be assumed; for in this case the source of the water, be it pond or river, is usually already impure from organic growth. In dealing with surface waters two objects are to be accomplished: first, the water must be freed from the organisms which it contains; and, second, it must be protected so that further growth is impossible. The only effective means that I know of by which organisms can be removed in quantities from water is filtration. The possibility of filtering a sufficient quantity of water to meet the requirements of the larger towns and cities is indeed a serious question, but it belongs rather to the province of a civil engineer than a biologist. Suffice it to say that a layer of fine sand an inch in thickness is of itself a sufficiently good filter to remove all of the algæ and animals from a water as rich in organisms as the Cochituate water of Boston (see the following experiment on the growth of sponges). It will be recalled that the filtration of surface water by means of sand or gravel filters is sometimes attended with a growth of Crenothrix.

As I have previously mentioned, this growth take place especially when the filtration is rapid and more or less incomplete. If the filtration could be accomplished more slowly, so that the surface water could completely undergo those changes which convert it into a ground water, there is very little doubt but that the growth of Crenothrix in the filters, or subsequently in the water itself, would be insignificant.

Once having freed the surface water from its organisms and organic impurities, its subsequent treatment is essentially the same as that for a ground water. In order to preserve it free from organic growth it is only necessary to protect it from the light. The general plan for dealing with surface waters, then, consists in converting them into ground waters by slow filtration and then protecting them from the further growth of organisms by excluding the light.

The methods of improvement herein suggested have to some extent received experimental confirmation.

The desirability of preventing the exposure of ground waters to the light has been fully demonstrated in the case of the high-service tank at Brookline (see nineteenth annual report of the State Board of Health of Massachusetts, p. 89). It may here be remarked that this tank has remained covered since the first experiment was made, and that no objectionable growth has as yet appeared in it. I have not subjected to an actual test the plan suggested for the improvement of surface waters by filtration; but the experiment made on sponges bears on this question.

VI. — The Growth of Sponges in Water Supplies.

In order to understand the more characteristic habits of sponges, a slight knowledge of their structure is essential. A brief account of the anatomy of a sponge forms, therefore, an appropriate introduction to the consideration of the present topic.

Fresh-water sponges occur as thin incrustations on objects which are permanently submerged in water. They are usually from a quarter to three-quarters of an inch in thickness, and form irregular patches a foot or less in diameter. Under favorable circumstances, however, sponges can spread over areas many feet in extent, so that they can scarcely be said to have a characteristic limit in size. Although at times they extend over large areas they do not thicken proportionally, but retain, rather, the general form of relatively thin incrustations. Occasionally they produce finger-like projections, and these can attain even the length of several inches.

A more careful examination of the somewhat uneven outer surface of a sponge shows it to be marked here and there by elevations which resemble in form small volcanic cones. Each cone is provided with a central crater penetrating the substance of the sponge. The sides of the cones, as well as the areas between neighboring cones, are perforated by an immense number of fine pores. An examination of a living sponge shows that the water is being sucked in continually through these fine pores and that a strong current is setting out from the crater-like opening or osculum. The soft substance of the sponge's body is penetrated by a system of canals connecting the small lateral pores with the oscula. It is by means of delicate moving lashes in these canals that the water is whipped onward to the oscula and new water is drawn in at the pores. One of the chief purposes of this system of tubes is to enable the sponge to get its food. The water entering the fine pores usually contains many microscopic organisms, and, while passing through the canals in the body of the sponge, many of these organisms are caught and assimilated by the living walls of the tube.

From what has been said on the structure of sponges two peculiarities in their method of occurrence can be explained. Sponges do not thrive well in quiet water. They are firmly attached to the objects on which they rest, and they can create currents of only limited extent in the surrounding water. If, then, this water be at rest or very sluggish in its movements, the supply of food which it contains would soon be exhausted and the sponge would be in danger of starvation. General movements in the water are, therefore, necessary to carry food to the sponge, and consequently sponges thrive best in running water. A second peculiarity of the sponge is that it very seldom occurs on submerged surfaces which face upward. This peculiarity is due to the fact that, even in apparently clear water, there is usually more or less sedimentation, and the falling of sediment on a sponge so clogs its smaller pores as to render them useless. Sponges in positions where their pores can be filled with sediment are thus easily killed, and it is usually only on submerged surfaces which face downward, or which at least have no upward exposure, that these organisms thrive.

The color of sponges varies from light ochre to dark brown, gray or greenish. Greenish sponges contain chlorophyl, the green coloring matter found in green plants; and, like these plants, green sponges grow only in situations accessible to the light.

The living substance of the sponge is soft and unresisting, but it is penetrated in all directions by an immense number of microscopic flinty needles or spicules. These, like the bones of the higher animals, play the part of a supporting skeleton. At the death of a sponge the softer parts decay and the spicules are liberated. The spicules are almost indestructible, and consequently can be carried long distances in currents of water. They afford indisputable evidence of a growth of sponge. Different kinds of sponges are distinguished by different kinds of spicules. The characteristic spicules are not, however, the common spicules of the sponge's body, but spicules which surround the winter buds or gemmules.

At different seasons of the year the sponge presents very different appearances. Vigorous growths of young sponge are noticed first in early summer. They continue to increase in size till early fall, when they reach their maximum growth. During this summer period of excessive activity more or less decay is going on, and with decay comes the liberation of spicules. In the fall the sponge becomes less vigorous in appearance, and small parts of its flesh separate from the rest and are surrounded by a layer of peculiarly shaped spicules. The little bodies thus formed are called gemmules and are about the size of small grains of sand. After their formation the rest of the sponge dies and wastes away, the gemmules being left imbedded in the mass of spicules representing the dead body of the sponge. In this way the gemmule rests over winter, and in the following spring its living contents emerge from the protecting covering, and, together with living material from many other similar gemmules, begin a new sponge structure on the site of last year's growth. Thus it is seen that the sponge is active in the summer and fall and quiescent in winter and early spring.

The species of American fresh-water sponges are numerous, and for an account of these the reader is referred to a paper entitled "Fresh-Water Sponges; a Monograph," by Edward Potts (Proceedings Acad. Nat. Sciences, Philadelphia, 1887, pp. 158–279, plates v–xii.).

The time of year when sponge spicules are most generally met with has already been pointed out in the tables of seasonal distribution. It will be remembered that sponge spicules were most generally present in August, and that they were least frequently noticed in January. The following table, which is made from those showing the distribution of organisms in the water of Boston and Charlestown, presents essentially the same features : —

		July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June.
Boston, . . .	First year, .	abd.	sev.	sev.	few	pr.	pr.	–	few	–	–	–	few
	Second year,	few	few	few	few	few	–	few	–	few	–	–	few
Charlestown, . .	First year, .	pr.	pr.	few	few	pr.	–	sev.	few	–	–	–	–
	Second year,	few	–	few	few	few	few	–	–	few	–	–	–

Sponge spicules were generally present in the water of these supplies from July to December. For the remainder of the year they were only sparingly found at rather irregular intervals. It will thus be observed that the period when spicules were frequently met with, namely, from July to December, corresponds very closely with what has been described as a period of active growth, namely, during the summer and fall.

After having ascertained the presence of spicules in the water of Boston and Charlestown, it was a question of some interest to locate the growth of sponge. In order to do this the water which was about leaving the reservoir to enter the mains was carefully examined. In the examination of the water from both Chestnut Hill and College Hill reservoirs no traces of spicules were discovered. Since at this time (July, 1887) spicules were abundant in the water delivered in both Boston and Charlestown, it was concluded that in both systems the growth of sponge was somewhere in the pipes between the reservoirs and the points of delivery.

After this conclusion as to the location of the sponge was reached no further steps were taken until it was ascertained that, on account of a change in level of a street, certain of the Boston mains were to be opened. One of the large mains was disconnected about one mile from Chestnut Hill Reservoir. It was examined Nov. 22, 1887, and was found to contain two organisms: a sponge, Tubella Pennsylvanica (Potts), and a snail of the genus Physa. The sponge, after the escape of the water from the pipe, had of course dried and was consequently dead; some of the snails were alive, others dead. The sponge was limited to the upper two-thirds of the pipe and covered about three-fourths of that surface, or about one-half of the total inner surface of the pipe. The absence of the sponge from the bottom of the pipe was probably due to the effect of sedimentation, which has already been explained. Most of the sponges were thin incrustations, but occasionally finger-like projections extended out from the surface of the pipe. These always pointed in the direction of the current in the pipe. For the most

part gemmules had been formed; and the sponges in the pipe were in the same stage of development as those in open water. The particular form in which the sponges grew was interesting. Many of them were in circles, the central area of which was covered with a few rust-covered spicules. They had evidently started to grow from a centre, which in time had died and decomposed, leaving only the periphery alive. The snails found in the pipes were small in size and apparently dwarfed. There was on an average one snail for every three feet in length of the pipe.

The presence of sponge in the principal mains of the Boston system is beyond dispute, but whether the growth extends to the smaller pipes or not is an open question. The examination of the scrapings from the interior of a pipe at the corner of Fourth and L streets, South Boston, showed no sponge spicules. The pipe was twelve inches in diameter and had been in use since 1860. This would rather indicate that the growth of sponge is limited to the larger pipes.

There can be no doubt that a growth of sponge in the pipes of a water supply is an objectionable feature. The slow but continual disintegration of the sponge probably plays a considerable part in the production of disagreeable odors and tastes.

In attempting to find some effectual means by which the growth of the sponge can be checked, or possibly completely prevented, it is important to bear in mind that sponges, as well as all other animals in the pipes, are dependent for their food upon organic material carried to them by the water. The food thus supplied consists of a few microscopic animals and a great number of equally small plants. If this supply of food could be cut off by filtration, then it would be but natural to expect the death of all organisms dependent upon it. In order to test the soundness of this conclusion the following experiment was made.

Two pieces of glass tubing, about one and a half inches in diameter and two feet long, were so arranged that a continuous current of water could be passing through them. Next to the upper surface of the inside of each tube a piece of wood with some sponge growing on it was suspended. The species of sponge used was Meyenia fluviatilis (Auct). Care was taken that the sponge should be in its normal position; i.e., oscula directed downward. The sponge was introduced into the tubes Saturday, June 23, at eleven A.M., and the water set running in each tube at the rate of 840 cubic centimeters per

minute. On Monday, June 25, both pieces of sponge were in healthy condition; their oscula were fully expanded and the action of their pores well established. The water used in the experiment was the Cochituate water of Boston, which at this time of year contained an abundant supply of algæ. At two P.M. on Monday a change was made in the character of water supplied to one of the tubes. The water supplied to the tube which can be designated as tube A, was passed through a sand filter before it entered the tube. This operation removed all the algæ, but in other respects left the water essentially as before the change. Tube B was still supplied with unfiltered water. On account of the slowness of filtration the rate of flow in Tube A was reduced to 120 cubic centimeters per minute. In order that the sponge in Tube B should not have an advantage over that in Tube A, the flow of unfiltered water in B was reduced to 100 cubic centimeters per minute. From time to time the water from Tube A was examined to ascertain whether the filter was removing all the algæ or not. No algæ were noticed in it. In this way the experiment was continued till Thursday, June 28, when the oscula of the sponge supplied with filtered water had disappeared and the sponge itself was very considerably whitened. The other sponge (B), although apparently not so healthy as at first, still extended its oscula and showed indications of life. On Thursday at nine A.M. each tube was supplied with unfiltered water at the rate of 900 cubic centimeters per minute. On Saturday, June 30, the sponge in Tube A had for the most part decomposed and disappeared, while that in Tube B had become as flourishing as it was originally.

The result of this experiment supports the statement already made, that, since the sponge depends upon the microscopic algæ, etc., for its food, it will not grow in any water free from them, and wherever it exists their removal will bring about its death.

Not only is this true of sponges but there is reason to believe that it is true of all animals which inhabit the pipes, for they all are dependent for their food upon organisms carried into the pipes with the water. Thus efficient filtration, if applied to the water as it passes from the reservoir into the distributing pipes, would not only remove organisms from the water itself, but, provided the water were not again exposed to the light, it would prevent a growth of animals in the pipe.

Further investigations in the direction indicated by the experiment

on the sponge are desirable both by way of confirming the present experiment and also by determining quantitatively the amount of algæ which must be removed before the death of the sponge follows. It is possible that a removal of a part of the algæ might result in as complete a mastery over the sponge as the removal of all.

Respectfully submitted,

G. H. PARKER.

CAMBRIDGE, MASS., December, 1889.

SUMMARY OF

WATER SUPPLY STATISTICS;

ALSO RECORDS OF

RAINFALL, FLOW OF STREAMS, AND TEMPERATURES OF AIR AND WATER.

By F. P. STEARNS,

ENGINEER OF THE BOARD.

EXAMINATIONS OF WATER SUPPLIES AND INLAND WATERS.

The duties of the engineer in connection with this work have been to determine under the general direction of the Board where samples of water should be collected, to arrange for their regular and systematic collection, and to obtain information regarding the physical characteristics of the water supplies and rivers examined,— such as the density of population on drainage areas, amount of polluting matter entering the streams, volume of water flowing, and temperature of water. Much of the information obtained is given in preceding portions of this report.

The results of chemical and biological examinations reported to the board have been tabulated by towns and sources, and studied to determine their relations to existing physical conditions and to troubles with the quality of the waters prevailing from time to time; also to determine in what directions further investigations were desirable, and where those already begun should be extended, diminished or discontinued.

In this work, and in the preparation of much material for this report, I have had as principal assistant Mr. X. H. Goodnough, and as other assistants Messrs. A. T. Safford and A. N. Wahlberg. At the beginning of the work, when a larger force was required, Prof. George F. Swain of the Massachusetts Institute of Technology and Mr. Henry D. Woods were temporarily engaged. Gauges for recording the flow of the streams were established by Mr. Richard A. Hale, and the volumes flowing were estimated by him.

As a first step toward the collection of statistics, the following circular and blank were prepared : —

OFFICE OF STATE BOARD OF HEALTH,
13 BEACON STREET, BOSTON, May 23, 1887.

To——— ———

The State Board of Health intends to make monthly analyses for the ensuing year of waters used for domestic supplies within the State, and in connection therewith desires to obtain general information respecting the

several water supplies. It therefore requests that you will send such printed information as you can; particularly reports describing the construction of your works, the occurrence of any unusual tastes, or growths of vegetation in or upon the water, or of any general disease affecting the fish in the streams, ponds and reservoirs.

An answer is requested to such of the questions in the accompanying blank as are applicable to your works.

The library of the Board now contains the reports mentioned below.

Respectfully yours,

F. P. Stearns,
Engineer, State Board of Health.

Commonwealth of Massachusetts.

State Board of Health.

Please fill out such portions of this blank as are applicable to your works, and forward to F. P. Stearns, Engineer, State Board of Health, 13 Beacon Street, Boston.

Some of the blanks have been filled from information now in the possession of the Board; please correct if wrong.

Date, ——— ——— 188

1. Name of city or town.
2. Population, 1885.
3. Date when works were built. (If not all built at one time, state what additions were made, and when.)
4. By whom are works owned?
5. Source or sources of water supply.
6. Area of watershed supplying such source or sources.
7. General geological and topographical character of the watershed.
8. Mode of supply, whether by gravity or pumping, and whether distributing reservoir or tank is used.
9. General description of storage and distributing reservoirs, — natural or artificial, how constructed, area of water surface, capacity, character of bottom, amount of shallow flowage, etc.
10. Does all water pumped go through the distributing reservoir or tank?
11. What portion of the water pumped goes into the distributing reservoir?
12. Whether or not the water is delivered into the distributing reservoir at one side and drawn out at the other.
13. Number, kind, size and depth of wells used as sources of water supply.
14. Describe filter galleries or basins, and connections, if any, with stream, pond or reservoir.
15. Daily average capacity of works in dry year.
16. Daily average consumption.
17. Number of persons using the water.
18. Is water supplied to any one outside of your town or city?

19. Material of distributing mains.
20. Material of service pipes.
21. Does the water supply receive sewage, drainage from factories (mentioning kind), or other pollutions?
22. If there have been any bad tastes in the water, or excess of vegetable growth, or if the fish have been generally affected, and such occurrences are not fully described in printed reports, please describe the same, and the remedy adopted, if any.
23. Have analyses of water from the present source been made? By whom? When? If not given in printed reports, please furnish copy of same.
24. Have records of the temperature of the water been taken in the past? If not printed, will you furnish copies, if blanks are sent?
25. Will you keep records of the temperature of water in the future, if a thermometer and blanks are furnished?
26. Will you furnish samples of water for analysis each month, and forward at stated times by express, if bottles are supplied?
27. To whom shall future correspondence be addressed.
28. Name and address of collector of samples.
29. Name of express company.
30. Name of person furnishing this information.

In addition to the information obtained from these returns, all public water supplies have been visited one or more times by the engineers of the Board, and complete sets of reports have been obtained and examined. In all of these investigations we have been greatly aided by the water works superintendents and others, who have kindly co-operated by collecting and forwarding samples of water, by taking such observations as were desired, and by promptly responding to requests for information.

In arranging where samples should be collected, care has been taken not only to get samples from which the present quality of the waters might be determined and a standard obtained for future comparisons, but also to determine general laws affecting the quality of water obtained or stored under different conditions. For instance, samples have been taken so that the ground water of filter galleries and wells can be compared with the surface water of adjacent ponds and streams; other samples show the effect of storing ground or surface waters in open reservoirs or in open or covered tanks; others, a comparison between water entering a storage reservoir and after standing in it; and others, the quality of water taken from a pond or reservoir at different depths. The results of these investigations will appear in a subsequent portion of this report.

WATER SUPPLY STATISTICS.

The following summary of water supply statistics represents the conditions existing at the end of the year 1889. The State then contained 25 cities and 326 towns. Out of this number, all of the cities and 107 towns, a total of 132 places, were wholly or in part provided with public water supplies. This statement does not include a number of towns, mostly in the western part of the State, where several families are supplied through a small pipe, by some individual or corporation, with water from a spring or stream on the neighboring hills; nor others, where a manufacturing village is supplied with water pumped at a mill.

The following table gives a classification by population of cities and towns, having and not having public water supplies, Dec. 31, 1889. The populations are taken from the census of 1885 : —

Population.	Number of Places of Given Population having a Public Water Supply.	Total Population of Places in Preceding Column.	Number of Places of Given Population not having a Public Water Supply.	Total Population of Places in Preceding Column.
Under 500,	1	451	22	7,530
500-1,000,	3	2,437	69	52,751
1,000-1,500,	5	6,450	40	48,399
1,500-2,000,	9	15,215	32	55,649
2,000-2,500,	10	22,057	21	47,233
2,500-3,000,	7	19,896	16	44,064
3,000-3,500,	3	9,168	7	22,521
3,500-4,000,	15	57,200	5	18,812
4,000-4,500,	11	47,398	4	16,938
4,500-5,000,	6	28,472	1*	4,555
5,000-5,500,	2	10,460	1†	5,436
5,500-6,000,	4	23,036	1‡	5,711
Above 6,000,	56	1,370,302	-	-
Totals,	132	1,612,542	219	329,599

* Millbury. † Blackstone. ‡ Andover. A system of water works has since been completed (1890).

From the totals given in this table it will be seen that, although but 37.6 per cent. of the cities and towns in the State have a public supply, yet the total population of the places supplied represents 83 per cent. of the whole population of the State. In this estimate of the population of the municipalities supplied, all of the inhabitants in them are included, and it consequently includes more than the actual number of persons to whom a public water supply is available; the difference, however, is not large. There are now but two towns which had in 1885 a population exceeding 4,500 which are not provided with a public water supply; the works in one town having been completed since the date of the table. Where the population exceeds 3,500 the majority are supplied, while below this the reverse is true. In some important towns the supply is limited to but one of several villages.

In the State there are 128 sources of public water supply, counting as a source each separate system of water works, and each of the sources used in connection with any particular system when essentially different in character. This does not agree exactly with the number of municipalities supplied; since in many cases a city, town or company supplies several places, while in others a city or town has several sources of supply. These sources may be divided as follows: —

Ground Water Sources.

Springs,	13
Large wells,	20
Tubular wells,	7
Filter-galleries,	10
Filter-basins,	4
Total,	54

Surface Water Sources.

Artificial storage reservoirs,	38
Natural ponds,	32
Streams,	4
Total,	74

The line of separation between the different classes is somewhat indefinite. A filter-gallery or well on the banks of a stream may each furnish water of identically the same character, while another well may furnish the water of a natural spring which it has replaced. Natural ponds, by having their level raised, may flow extensive meadows, and so become less satisfactory reservoirs than those that

are wholly artificial. Tubular wells are frequently sunk in the bottoms of large wells or filter-basins, with the view of increasing the supply of water; and in other ways the classification is somewhat complicated; yet it furnishes a fair idea of the sources from which the water supply of the State is obtained. In the next table the various water supplies are classified according to the dates when a fairly complete system of water supply was first introduced into a city or town.

Years.	Number of places supplied.
Previous to 1850,	6
1850-1859 inclusive,	4
1860-1869 inclusive,	10
1870-1879 inclusive,	44
1880-1889 inclusive,	68
Total,	132

This table shows the activity in water works construction since 1870. Before that time the total number of municipalities supplied was twenty, or less than one-sixth of the total number. More than one-half of the whole number have obtained a supply since 1880. No account is taken of important additional supplies which have been provided in many cases.

Of the 25 cities in the Commonwealth, 21, having a total population in 1885 of 1,042,032, own their water works; while 4, having a total population of 69,359, are wholly supplied by private companies. Of the 107 towns having a public water supply, 58, with a total population of 301,319, are supplied from their own works; and 49, with a total population of 199,832, by private companies. In this classification no account is taken of secondary supplies of small importance which exist in many places. The total population in both cities and towns owning their works is 1,343,351, against 269,191 in those supplied by private companies.

Rainfall.

The amount of rainfall, by reason of its effect upon the flow of streams and the height of water held in reservoirs, has an important effect upon the chemical and biological character of the waters.

The effect is obviously greatest upon waters which are polluted by sewage, although normal waters are often much affected by a greater or less amount of rainfall.

During the two years covered by the analyses printed in this report, the rainfall has been unusually large, and it has been favorably distributed for maintaining a high flow in the streams during the portion of the year when the flow is usually small.

The average annual rainfall* in Massachusetts, deduced from long-continued observations in various parts of the State, is 43.17 inches. From June, 1887, to May, 1888, inclusive, the total rainfall was 47.14 inches, and during the next year it was 53.74 inches; therefore, the excess on each of these two years was respectively 3.96 and 10.57 inches. Similar comparisons by months are given in the following table. The departure from the normal is given in bold-faced type: —†

	Normal Rainfall.	June, 1887, to May, 1888.	Excess or Deficiency.	June, 1888, to May, 1889.	Excess or Deficiency.
June,	3.31	3.42	**+0.11**	2.71	**—0.60**
July,	3.81	5.10	**+1.29**	2.67	**—1.14**
August,	4.12	6.07	**+1.95**	5.35	**+1.23**
September,	2.99	1.56	**—1.43**	8.78	**+5.79**
October,	3.67	2.68	**—0.99**	5.08	**+1.41**
November,	3.87	2.98	**—0.89**	6.85	**+2.98**
December,	3.49	4.10	**+0.61**	5.01	**+1.52**
January,	3.74	4.08	**+0.34**	5.31	**+1.57**
February,	3.63	3.70	**+0.07**	2.05	**—1.58**
March,	3.87	5.82	**+1.95**	2.38	**—1.49**
April,	3.34	2.76	**—0.58**	3.63	**+0.29**
May,	3.33	4.86	**+1.53**	3.92	**+0.59**
Total,	43.17	47.13	**+3.96**	53.74	**+10.57**

To enable the condition preceding the collection of samples of water in any part of the State to be understood, the following tables are presented, which give the daily rainfall in inches at ten stations scattered about the State: —

* Including melted snow.

† This and subsequent tables of rainfall have been prepared from the records of the New England Meteorological Society.

Daily Rainfall at Ten Places in Massachusetts, Geographically Selected.
May, 1887.

Day of Month.	Deerfield.	Ludlow.	Gilbertville.	Fitchburg.	Framingham.	Chestnut Hill, Boston.	Lawrence.	Salem.	Taunton.	New Bedford.
1, . . .	-	-		-	-	-	-	-	-	-
2, . . .	-	-		-	-	-	-	-	-	-
3, . . .	-			-	-	-	-	-	-	-
4, . . .	-	-		-	-	-	-	-	-	-
5, . . .	-	-		-	-	-	-	-	-	-
6, . . .	0.20	0.10		0.03	0.11	-	-	-	-	-
7, . . .	-	0.15		0.05	*	*	*	0.08	*	-
8, . . .	-	-		-	0.04	0.20	0.05	-	1.00	0.42
9, . . .	-	-		-	-	-	-	-	-	-
10, . . .	-	-		-	-	-	-	-	-	-
11, . . .	-	-		-	-	-	-	-	-	-
12, . . .	-	-		-	-	-	-	-	-	-
13, . . .	-	-		-	-	-	-	-	-	-
14, . . .	-	-		-	-	-	-	-	-	-
15, . . .	-	-	No record.	-	-	-	-	-	-	-
16, . . .	-	-		-	-	-	-	-	-	-
17, . . .	-	-		-	-	-	-	-	-	-
18, . . .	-	-		-	-	-	-	-	-	-
19, . . .	-	-		-	-	-	-	-	-	-
20, . . .	-	-		-	-	-	-	-	-	-
21, . . .	-	-		-	-	-	-	-	-	-
22, . . .	-	0.05		-	-	-	-	-	-	-
23, . . .	-	-		-	-	-	-	-	-	-
24, . . .	-	0.20		-	*	-	-	-	*	-
25, . . .	0.37	0.10		0.32	*	0.09	0.11	0.16	0.37	0.63
26, . . .	0.14	-		0.25	0.21	0.12	0.06	-	-	0.03
27, . . .	0.01	-		0.03	*	*	0.05	-	0.01	-
28, . . .	0.74	0.15		*	*	*	-	1.35	0.99	1.16
29, . . .	0.06	0.10		2.09	0.70	1.28	-	0.05	0.02	-
30, . . .	-	-		-	-	-	1.45	-	-	-
31, . . .	-	-		-	-	-	-	-	-	-
Totals, . .	1.52	0.85	-	2.77	1.06	1.69	1.72	1.64	2.39	2.24

* Precipitation included in that of following day.

Daily Rainfall at Ten Places in Massachusetts, Geographically Selected.
June, 1887.

Day of Month.	Deerfield.	Ludlow	Gilbertville.	Fitchburg.	Framingham.	Chestnut Hill, Boston.	Lawrence.	Salem.	Taunton.	New Bedford.
1, . . .	1.00	0.85	0.45	–	0.05	*	*	–	*	–
2, . . .	0.33	0.40	0.41	1.17	1.20	0.97	0.97	1.11	2.08	1.75
3, . . .	0.38	0.05	0.07	0.02	*	–	0.10	0.08	0.13	–
4, . . .	–	–	–	–	0.02	–	0.04	–	0.04	–
5, . . .	–	–	–	–	–	–	–	–	–	–
6, . . .	–	–	–	–	–	–	–	–	–	–
7, . . .	–	–	–	–	–	–	–	–	–	–
8, . . .	–	–	–	–	–	–	–	–	–	–
9, . . .	–	–	0.38	0.01	–	–	–	–	0.07	–
10, . . .	–	–	–	–	–	–	–	–	–	–
11, . . .	–	–	–	–	–	–	–	–	–	–
12, . . .	–	–	–	–	–	–	–	–	–	–
13, . . .	–	–	–	–	–	–	–	–	–	–
14, . . .	–	–	–	–	–	–	–	–	–	–
15, . . .	–	–	–	–	–	–	–	–	–	–
16, . . .	–	–	–	–	–	–	*	–	–	–
17, . . .	0.04	0.15	0.02	–	–	–	0.06	–	*	0.10
18, . . .	0.03	0.05	–	–	–	–	–	–	*	0.03
19, . . .	0.01	–	–	–	–	–	–	–	0.06	–
20, . . .	–	–	–	–	–	–	–	–	–	–
21, . . .	0.06	–	–	–	0.05	–	–	–	–	–
22, . . .	0.25	0.45	0.52	0.22	0.36	*	*	–	0.21	0.04
23, . . .	1.03	2.10	1.68	*	*	0.27	0.20	0.18	*	0.18
24, . . .	2.65	1.30	0.52	1.92	0.74	0.84	0.86	0.81	1.22	0.92
25, . . .	–	0.03	–	–	–	–	–	–	–	–
26, . . .	0.03	–	–	–	–	–	–	–	–	0.13
27, . . .	–	–	–	–	–	–	–	–	–	–
28, . . .	–	–	–	–	–	–	–	–	–	–
29, . . .	–	–	–	–	–	–	–	–	–	–
30, . . .	–	–	–	–	–	–	–	–	–	–
Totals, . .	5.81	5.38	4.05	3.34	2.42	2.08	2.23	2.18	3.81	3.15

* Precipitation included in that of following day.

Daily Rainfall at Ten Places in Massachusetts, Geographically Selected.
July, 1887.

Day of Month.	Deerfield.	Ludlow.	Gilbertville.	Fitchburg.	Framingham.	Chestnut Hill, Boston.	Lawrence.	Salem.	Taunton.	New Bedford.
1, . . .	0.14	-	-	-	-	-	-	-	-	-
2, . . .	-	-	-	-	-	-	-	-	-	-
3, . . .	-	-	-	-	-	-	0.06	-	-	-
4, . . .	-	-	-	-	-	-	-	-	-	-
5, . . .	-	-	-	-	-	-	-	-	-	-
6, . . .	0.78	0.50	0.37	0.22	0.03	-	0.04	-	-	-
7, . . .	0.03	0.20	0.02	-	-	-	-	-	0.05	0.11
8, . . .	-	-	-	-	-	-	-	-	-	-
9, . . .	-	-	-	0.80	*	-	-	-	0.58	-
10, . . .	0.12	0.15	0.07	0.13	0.74	*	0.41	0.59	0.54	1.64
11, . . .	0.01	-	0.02	-	*	*	0.22	-	0.30	-
12, . . .	-	-	-	-	0.30	1.10	0.58	0.28	-	-
13, . . .	-	-	-	-	-	-	-	-	-	-
14, . . .	-	-	-	-	-	-	-	-	-	-
15, . . .	-	0.05	-	-	-	-	-	-	-	-
16, . . .	0.19	0.05	0.07	-	-	-	-	-	-	0.04
17, . . .	1.21	0.40	1.30	0.31	*	*	-	0.01	1.48	0.60
18, . . .	0.07	1.20	0.63	0.04	0.44	0.14	0.11	0.04	-	-
19, . . .	-	-	0.05	0.01	-	-	-	-	-	-
20, . . .	-	-	-	-	-	-	-	-	-	-
21, . . .	0.32	0.20	0.03	0.13	*	-	*	-	-	-
22, . . .	0.78	0.45	0.48	0.52	*	1.16	0.43	1.12	0.64	1.00
23, . . .	1.02	0.95	1.33	*	*	0.91	*	0.86	1.32	0.03
24, . . .	5.39	1.17	1.32	4.51	2.05	0.18	1.58	0.02	0.05	-
25, . . .	-	0.05	0.05	-	-	-	0.18	-	-	-
26, . . .	0.04	-	0.08	0.07	-	-	-	-	-	-
27, . . .	-	0.20	-	0.01	-	-	-	-	-	-
28, . . .	-	-	-	-	-	-	-	0.78	-	-
29, . . .	0.19	0.10	0.22	0.48	0.25	0.20	0.07	-	-	-
30, . . .	-	-	0.02	-	-	-	-	-	-	-
31, . . .	0.37	-	-	-	-	-	-	-	1.29	0.19
Totals, .	10.66	5.67	6.06	7.23	3.81	3.69	3.68	3.70	6.25	3.61

* Precipitation included in that of following day.

Daily Rainfall at Ten Places in Massachusetts, Geographically Selected.
August, 1887.

Day of Month.	Deerfield.	Ludlow.	Gilbertville.	Fitchburg.	Framingham.	Chestnut Hill, Boston.	Lawrence.	Salem.	Taunton.	New Bedford.
1, . . .	–	0.10	–	–	–	–	–	–	–	–
2, . . .	0.72	0.55	0.39	0.17	0.87	0.36	0.12	0.24	0.07	2.62
3, . . .	1.38	0.50	0.23	–	–	–	–	–	–	–
4, . . .	–	–	–	–	–	–	–	–	–	–
5, . . .	0.01	–	–	–	–	–	–	–	–	–
6, . . .	0.21	0.30	0.46	0.39	0.11	0.13	2.03	0.17	0.04	–
7, . . .	–	–	–	–	–	–	–	–	–	–
8, . . .	–	–	–	–	–	–	–	–	–	–
9, . . .	–	–	–	–	–	–	–	–	–	–
10, . . .	–	–	–	–	–	–	–	–	–	–
11, . . .	0.73	0.20	0.45	0.58	0.75	0.38	*	0.29	0.22	–
12, . . .	–	–	–	–	–	–	0.64	–	0.07	0.48
13, . . .	–	–	–	–	–	–	–	–	–	–
14, . . .	–	–	–	–	–	–	–	–	–	–
15, . . .	–	–	–	–	–	–	–	–	–	0.01
16, . . .	–	–	–	–	–	–	–	–	–	–
17, . . .	–	–	–	–	–	–	–	–	–	–
18, . . .	1.00	2.70	–	2.73	0.93	0.45	3.29	0.36	0.49	0.03
19, . . .	–	–	2.80	–	–	–	–	–	–	0.13
20, . . .	0.39	0.12	–	0.38	0.20	0.52	0.20	0.79	0.04	0.18
21, . . .	–	–	–	–	*	–	–	–	–	–
22, . . .	2.05	1.00	0.12	3.22	*	*	2.27	2.62	1.86	–
23, . . .	–	0.23	0.20	1.19	*	*	*	0.35	0.70	–
24, . . .	–	1.40	0.14	0.91	1.55	1.69	*	0.86	0.96	–
25, . . .	–	0.10	–	–	–	–	1.57	–	0.04	3.16
26, . . .	–	–	–	–	–	–	–	–	–	–
27, . . .	–	–	–	–	–	–	–	–	–	–
28, . . .	–	–	–	–	–	–	–	–	–	–
29, . . .	–	–	0.26	0.13	–	–	0.05	–	–	–
30, . . .	0.01	0.10	–	0.07	0.21	–	0.06	–	0.66	–
31, . . .	0.04	–	–	–	–	–	–	–	–	–
Totals, . .	6.54	7.30	5.05	9.77	4.62	3.53	10.23	5.68	5.15	6.61

* Precipitation included in that of following day.

Daily Rainfall at Ten Places in Massachusetts, Geographically Selected. September, 1887.

Day of Month.	Deerfield.	Ludlow.	Gilbertville.	Fitchburg.	Framingham.	Chestnut Hill, Boston.	Lawrence.	Salem.	Taunton.	New Bedford.
1, . . .	–	–	–	–	–	–	–	–	–	–
2, . . .	–	0.05	–	–	0.01	–	–	–	*	–
3, . . .	–	–	–	–	–	–	–	–	0.04	–
4, . . .	–	–	–	–	–	–	–	–	–	–
5, . . .	–	–	–	–	–	–	–	0.13	–	–
6, . . .	–	–	–	–	–	–	*	0.15	–	–
7, . . .	0.85	0.35	0.68	1.75	0.53	0.61	0.22	–	0.90	0.11
8, . . .	–	0.25	0.02	–	–	–	2.26	–	0.01	–
9, . . .	–	–	–	–	–	–	–	0.21	–	–
10, . . .	0.10	0.15	0.15	0.09	0.18	0.24	0.22	–	0.15	0.04
11, . . .	–	–	–	–	–	–	–	–	–	–
12, . . .	0.25	0.20	0.33	*	*	0.32	*	0.16	*	–
13, . . .	0.37	0.10	0.07	0.44	*	–	*	–	0.34	1.10
14, . . .	0.03	0.05	–	–	0.40	–	0.24	–	–	–
15, . . .	–	–	–	–	–	–	–	–	–	–
16, . . .	–	–	–	–	–	–	–	–	–	–
17, . . .	–	–	–	–	–	–	–	–	–	–
18, . . .	–	–	–	–	–	–	–	–	–	–
19, . . .	–	–	–	–	–	–	–	–	–	–
20, . . .	–	–	–	–	–	–	–	–	–	–
21, . . .	–	–	–	–	–	–	–	–	–	–
22, . . .	0.04	0.05	0.11	0.09	0.10	0.14	0.30	0.13	0.09	0.10
23, . . .	0.04	–	–	–	–	–	–	–	0.05	0.21
24, . . .	–	–	–	–	–	–	–	–	–	–
25, . . .	–	–	–	–	–	–	–	–	–	–
26, . . .	–	–	–	–	–	–	–	–	–	–
27, . . .	–	–	–	–	–	–	–	–	–	–
28, . . .	–	–	–	–	–	–	–	–	–	–
29, . . .	–	0.20	0.10	0.08	*	0.04	0.02	0.01	0.08	0.12
30, . . .	0.11	0.05	0.05	–	0.07	–	–	–	0.05	–
Totals, . .	1.79	1.45	1.51	2.45	1.29	1.35	3.26	0.79	1.71	1.68

* Precipitation included in that of following day.

Daily Rainfall at Ten Places in Massachusetts, Geographically Selected.
October, 1887.

Day of Month.	Deerfield.	Ludlow.	Gilbertville.	Fitchburg.	Framingham.	Chestnut Hill, Boston.	Lawrence.	Salem.	Taunton.	New Bedford.
1, . . .	0.05	0.30		0.58	0.73	1.00	0.84	0.41	0.69	1.60
2, . . .	0.53	0.15		0.08	0.11	0.06	0.05	0.03	0.20	0.07
3, . . .	0.12	0.05		0.10	0.10	0.09	0.13	0.12	0.01	0.05
4, . . .	0.17	0.05		–	0.07	–	0.11	0.41	0.06	0.08
5, . . .	–	–		–	0.02	–	–	–	–	–
6, . . .	–	–		–	–	–	–	–	–	–
7, . . .	–	–		–	–	–	–	–	–	–
8, . . .	–	–		–	–	–	–	–	–	–
9, . . .	–	–		–	–	–	0.03	–	–	–
10, . . .	–	–		–	–	–	–	–	–	–
11, . . .	0.39	0.35		0.21	0.46	0.76	0.66	0.64	0.68	0.37
12, . . .	–	–		–	–	–	–	–	–	–
13, . . .	–	–		–	–	–	–	–	–	–
14, . . .	–	–		–	–	–	–	–	–	–
15, . . .	–	–	No record.	–	–	–	–	–	–	–
16, . . .	–	–		–	–	–	–	–	–	–
17, . . .	–	–		–	–	–	–	–	–	–
18, . . .	–	–		–	–	–	–	–	0.04	–
19, . . .	–	–		–	–	–	–	–	–	–
20, . . .	–	–		*	*	–	–	–	*	–
21, . . .	1.32	1.10		1.02	1.38	1.30	1.11	1.21	1.24	1.72
22, . . .	–	–		–	–	–	–	–	–	–
23, . . .	–	–		–	–	–	–	–	–	–
24, . . .	–	0.05		–	–	–	–	–	0.01	–
25, . . .	–	–		–	–	–	–	–	–	–
26, . . .	–	–		–	–	–	–	–	–	–
27, . . .	–	–		–	–	–	–	–	–	–
28, . . .	–	–		–	–	–	–	–	–	0.06
29, . . .	–	–		–	–	–	–	–	–	–
30, . . .	–	–		–	–	–	–	–	–	–
31, . . .	–	–		–	–	–	–	–	–	–
Totals, . .	2.58	2.05	–	1.99	2.87	3.21	2.93	2.82	2.93	3.95

* Precipitation included in that of following day.

Daily Rainfall at Ten Places in Massachusetts, Geographically Selected. November, 1887.

Day of Month.	Deerfield.	Ludlow.	Gilbertville.	Fitchburg.	Framingham.	Chestnut Hill, Boston.	Lawrence.	Salem.	Taunton.	New Bedford.
1, . . .	–	–	–	–	–	–	–	–	–	0.05
2, . . .	–	–	–	–	–	–	–	–	–	–
3, . . .	–	–	–	–	–	–	–	–	–	–
4, . . .	–	0.02	–	–	–	–	–	–	–	–
5, . . .	–	–	0.06	–	–	–	–	–	–	–
6, . . .	–	–	–	–	–	–	–	–	–	–
7, . . .	–	–	–	–	–	–	–	–	–	–
8, . . .	–	–	–	–	–	–	–	–	–	–
9, . . .	–	–	–	–	–	–	–	–	–	–
10, . . .	–	–	0.73	0.99	0.76	0.82	*	1.17	0.97	0.96
11, . . .	0.75	0.75	0.13	0.02	–	–	0.98	–	–	–
12, . . .	–	–	–	–	–	–	–	–	–	–
13, . . .	–	–	–	–	–	–	–	–	–	–
14, . . .	–	–	–	–	–	–	–	–	–	–
15, . . .	0.85	0.85	0.92	1.02	0.87	1.15	1.26	1.39	1.00	1.04
16, . . .	–	0.15	0.06	0.02	0.06	0.09	0.02	0.04	0.10	0.09
17, . . .	–	–	–	–	–	–	–	–	–	–
18, . . .	–	–	–	–	–	–	–	–	–	–
19, . . .	–	0.20	0.34	0.63	0.34	0.20	*	0.11	*	0.20
20, . . .	0.84	0.22	0.14	–	–	–	0.29	–	0.15	–
21, . . .	–	–	–	–	–	–	–	–	–	–
22, . . .	–	–	–	–	–	–	–	–	–	–
23, . . .	0.01	0.02	0.02	0.01	–	–	0.07	–	–	–
24, . . .	–	–	0.01	–	*	–	–	–	–	–
25, . . .	0.58	0.45	0.47	*	*	0.25	*	0.30	0.05	–
26, . . .	0.09	0.03	0.05	0.40	0.32	–	0.27	–	–	–
27, . . .	0.02	–	–	–	–	–	–	–	–	–
28, . . .	0.42	0.75	0.59	0.30	0.29	0.24	*	0.13	0.05	–
29, . . .	–	–	–	–	–	–	0.36	–	–	0.26
30, . . .	–	–	–	–	–	–	–	–	–	–
Totals, . .	3.56	3.44	3.52	3.39	2.64	2.75	3.25	3.14	2.32	2.60

* Precipitation included in that of following day.

Daily Rainfall at Ten Places in Massachusetts, Geographically Selected.
December, 1887.

Day of Month.	Deerfield.†	Ludlow.	Gilbertville.	Fitchburg.	Framingham.	Chestnut Hill, Boston.	Lawrence.	Salem.	Taunton.	New Bedford.
1, . . .	–	–	–	–	–	–	–	–	–	–
2, . . .	–	–	–	–	–	–	–	–	–	–
3, . . .	–	–	–	0.04	0.03	–	0.08	0.02	0.03	–
4, . . .	–	–	–	–	–	–	–	–	–	–
5. . . .	–	0.40	0.44	0.28	0.13	0.14	0.23	0.13	0.20	0.19
6, . . .	–	–	–	–	–	–	–	–	–	–
7, . . .	–	–	–	–	–	–	–	–	–	–
8, . . .	–	–	–	–	–	–	–	–	–	0.04
9, . . .	–	–	–	–	–	–	–	–	–	–
10, . . .	–	0.03	0.11	*	*	*	*	–	*	–
11, . . .	1.43	0.75	0.53	0.93	*	*	*	*	*	–
12, . . .	–	0.15	0.11	–	0.95	0.78	0.98	0.86	1.20	1.47
13, . . .	–	–	–	–	–	–	–	–	–	–
14, . . .	–	–	–	–	–	–	–	–	–	–
15, . . .	0.55	0.38	0.40	*	0.76	0.68	*	0.57	*	–
16, . . .	–	0.15	0.14	0.40	–	–	0.61	–	0.72	0.60
17, . . .	–	–	–	–	–	–	–	–	–	–
18, . . .	–	0.42	*	0.26	0.54	0.52	*	0.73	*	–
19, . . .	–	–	0.55	–	–	–	0.43	–	0.67	0.63
20, . . .	–	–	–	–	*	–	–	0.36	–	–
21, . . .	–	0.28	0.33	0.55	0.32	0.23	0.48	–	0.32	0.31
22, . . .	–	–	–	0.03	–	–	0.09	0.02	–	–
23, . . .	–	–	–	–	–	–	–	–	–	–
24, . . .	–	–	–	–	–	–	–	–	–	–
25, . . .	–	–	–	–	–	–	–	*	–	–
26, . . .	–	–	*	*	*	*	*	0.36	–	–
27, . . .	1.47	0.60	0.15	0.17	0.28	0.47	0.20	–	0.17	0.22
28, . . .	–	1.05	1.33	1.38	0.90	0.84	0.95	0.64	1.00	0.82
29, . . .	–	–	–	–	–	–	–	–	–	–
30, . . .	–	–	–	–	–	–	–	–	–	–
31, . . .	–	0.10	–	–	0.03	–	–	–	–	–
Totals, . .	4.50	4.31	4.09	4.04	3.94	3.66	4.05	3.69	4.31	4.28

* Precipitation included in that of following day.

† The daily records at Deerfield for this month include only the precipitation in the form of rain; the total however gives the entire precipitation as in other cases.

Daily Rainfall at Ten Places in Massachusetts, Geographically Selected.
January, 1888.

Day of Month.	Deerfield.	Ludlow.	Gilbertville.	Fitchburg.	Framingham.	Chestnut Hill, Boston.	Lawrence.	Salem.	Taunton.	New Bedford.
1, . . .	*	1.00	1.08	1.36	*	*	*	*	*	*
2, . . .	1.37	0.50	0.36	-	1.42	1.38	1.49	1.44	1.40	1.67
3, . . .	-	-	-	-	-	-	-	-	-	-
4, . . .	-	*	0.15	*	0.11	*	0.08	0.07	*	-
5, . . .	-	0.10	-	0.07	-	0.08	-	-	0.12	0.10
6, . . .	-	*	-	-	-	-	-	-	-	-
7, . . .	-	0.05	0.05	-	0.08	-	*	0.01	*	0.05
8, . . .	0.33	0.20	0.25	0.07	0.09	0.17	0.05	0.02	0.05	0.15
9, . . .	-	-	-	-	-	-	-	-	-	-
10, . . .	1.50	0.20	0.16	0.13	0.13	0.12	0.15	0.17	0.30	0.27
11, . . .	-	-	-	-	-	-	-	-	-	-
12, . . .	-	-	-	-	-	-	-	-	-	-
13, . . .	0.85	0.55	0.51	0.47	0.52	0.47	0.40	0.35	0.46	0.28
14, . . .	-	-	-	-	-	-	-	-	-	0.63
15, . . .	0.33	0.15	0.14	0.23	0.14	0.08	0.21	0.09	0.02	0.05
16, . . .	-	-	-	-	-	-	-	-	-	-
17, . . .	*	*	*	0.72	*	*	*	0.74	*	*
18, . . .	0.66	0.27	0.24	-	0.73	0.76	0.67	-	0.45	0.45
19, . . .	-	-	-	-	-	-	-	-	-	-
20, . . .	-	-	-	-	-	-	-	-	-	-
21, . . .	-	-	-	-	-	-	-	-	-	-
22, . . .	-	-	-	0.07	-	-	-	-	-	-
23, . . .	-	-	-	-	0.03	*	0.04	0.03	*	0.08
24, . . .	-	0.02	-	-	-	0.02	-	-	0.04	-
25, . . .	*	*	*	*	*	*	*	*	-	-
26, . . .	1.20	0.45	0.94	1.53	0.94	0.80	1.36	0.78	0.68	0.80
27, . . .	-	-	-	-	-	-	-	-	-	0.03
28, . . .	-	-	-	-	-	-	-	-	-	-
29, . . .	-	-	-	-	-	-	-	-	-	-
30, . . .	-	-	-	-	-	-	-	-	-	-
31, . . .	-	-	-	-	-	-	-	-	-	-
Totals, . .	6.24	3.49	3.88	4.65	4.19	3.88	4.45	3.70	3.52	4.56

* Precipitation included in that of following day.

Daily Rainfall at Ten Places in Massachusetts, Geographically Selected.
February, 1888.

Day of Month.	Deerfield.	Ludlow.	Gilbertville.	Fitchburg.	Framingham.	Chestnut Hill, Boston.	Lawrence.	Salem.	Taunton.	New Bedford.
1, . . .	–	–	–	–	–	–	–	–	–	–
2, . . .	–	–	–	–	–	–	–	–	–	–
3, . . .	–	–	–	–	–	–	–	–	–	–
4, . . .	*	*	*	*	*	0.45	*	*	*	*
5, . . .	1.80	0.50	0.84	0.83	0.66	–	0.74	0.43	0.48	0.48
6, . . .	–	0.05	–	–	–	–	–	–	–	–
7, . . .	–	*	–	*	0.14	0.06	0.18	–	*	0.05
8, . . .	0.36	0.55	–	0.18	0.05	0.10	–	0.06	0.30	0.22
9, . . .	–	–	–	–	–	–	–	–	–	–
10, . . .	*	*	–	*	*	*	*	*	*	*
11, . . .	1.28	0.75	0.78	0.64	0.84	*	0.61	0.73	0.35	0.26
12, . . .	–	–	–	–	–	0.70	–	–	–	0.41
13, . . .	–	–	–	–	–	–	–	–	–	–
14, . . .	–	–	–	–	–	–	–	0.02	–	0.01
15, . . .	–	–	–	–	–	–	0.03	–	–	–
16, . . .	–	–	–	–	–	–	–	–	–	–
17, . . .	–	–	–	–	–	–	–	–	–	–
18, . . .	–	0.10	–	–	0.04	–	–	–	–	0.03
19, . . .	–	–	–	–	–	–	–	–	–	–
20, . . .	*	1.50	*	*	*	*	*	*	*	*
21, . . .	1.65	0.40	2.15	1.95	1.19	1.17	1.66	0.73	1.00	0.84
22, . . .	–	–	–	–	–	–	–	–	–	–
23, . . .	–	–	–	–	–	–	–	–	–	–
24, . . .	–	–	–	–	–	–	–	–	–	–
25, . . .	*	0.60	*	*	*	0.86	*	*	*	*
26, . . .	0.78	0.20	0.59	0.96	0.79	–	0.83	0.73	0.95	0.69
27, . . .	–	–	–	–	–	–	–	–	–	–
28, . . .	–	–	–	–	–	–	–	–	–	–
29, . . .	–	–	–	–	–	–	–	–	–	–
Totals, . .	5.87	4.65	4.36	4.56	3.71	3.34	4.05	2.70	3.08	2.99

* Precipitation included in that of following day.

Daily Rainfall at Ten Places in Massachusetts, Geographically Selected.
March, 1888.

Day of Month.	Deerfield.	Ludlow.	Gilbertville.	Fitchburg.	Framingham.	Chestnut Hill, Boston.	Lawrence.	Salem.	Taunton.	New Bedford.
1, . . .	–	–	–	–	0.02	–	–	–	0.03	0.01
2, . . .	–	*	–	0.18	*	*	–	–	0.14	–
3, . . .	–	0.15	–	–	0.04	0.14	0.09	0.06	–	0.10
4, . . .	–	–	–	–	–	–	–	–	–	–
5, . . .	–	–	–	–	–	–	–	–	–	–
6, . . .	–	–	–	–	–	–	–	–	–	–
7, . . .	–	–	–	–	–	–	–	–	–	–
8, . . .	–	–	–	–	–	–	–	–	–	–
9, . . .	–	–	–	–	–	–	–	–	–	–
10, . . .	–	–	–	–	–	–	–	–	–	–
11, . . .	*	*	–	*	*	–	–	–	–	*
12, . . .	*	*	*	*	*	*	*	2.18	*	1.29
13, . . .	*	2.50	*	*	*	2.33	1.76	0.10	1.10	*
14, . . .	3.22	0.40	4.00	2.74	3.33	0.26	0.18	–	*	0.13
15, . . .	–	–	–	–	–	–	0.02	–	0.13	–
16, . . .	–	–	–	–	–	–	–	–	–	–
17, . . .	–	–	–	–	–	–	–	–	–	–
18, . . .	–	–	–	–	–	–	–	–	–	–
19, . . .	–	–	–	–	–	–	–	–	–	–
20, . . .	*	*	*	*	*	*	*	*	*	*
21, . . .	*	1.40	1.20	0.99	*	1.16	*	*	1.00	1.78
22, . . .	1.30	0.25	–	–	1.04	–	1.18	1.06	–	–
23, . . .	–	–	–	–	–	–	–	–	–	–
24, . . .	–	–	–	–	–	–	–	–	–	–
25, . . .	–	–	–	–	–	–	–	–	–	–
26, . . .	*	1.50	*	0.91	*	*	*	*	*	*
27, . . .	1.42	1.05	*	0.31	*	0.89	*	1.15	1.01	1.55
28, . . .	0.03	0.20	*	*	*	0.52	1 54	0.31	*	0.74
29, . . .	0.27	0.20	1.45	0.04	1.84	0.23	0.17	0.31	0.71	0.18
30, . . .	–	–	–	–	–	–	–	–	–	–
31, . . .	–	–	–	–	–	–	–	–	–	–
Totals, . .	6.24	7.65	6.65	5.17	6.27	5.53	4.94	5.17	4.12	5.78

* Precipitation included in that of following day.

Daily Rainfall at Ten Places in Massachusetts, Geographically Selected.
April, 1888.

Day of Month.	Deerfield.	Ludlow.	Gilbertville.	Fitchburg.	Framingham.	Chestnut Hill, Boston.	Lawrence.	Salem.	Taunton.	New Bedford.
1, . . .	*	*	*	*	*	*	*	*	*	0.12
2, . . .	1.03	0.35	0.52	1.23	0.58	0.73	1.41	1.15	0.40	0.02
3, . . .	–	–	–	–	–	–	–	–	–	–
4, . . .	–	–	–	–	–	–	–	–	–	–
5, . . .	*	*	*	*	*	*	*	*	*	*
6, . . .	0.68	1.15	1.15	0.80	0.89	0.83	0.81	0.83	1.05	1.36
7, . . .	–	–	–	–	–	–	–	–	–	–
8, . . .	–	–	–	–	–	–	–	–	–	–
9, . . .	–	–	–	–	–	–	–	–	–	–
10, . . .	*	*	*	*	*	*	*	*	*	*
11, . . .	1.00	0.76	0.67	0.88	0.57	0.55	0.71	0.73	0.57	0.75
12, . . .	0.04	0.15	0.12	0.04	0.02	–	0.03	0.06	–	0.01
13, . . .	–	–	–	–	–	–	–	–	–	0.01
14, . . .	0.05	0.10	0.08	0.07	*	0.09	*	0.17	*	0.11
15, . . .	–	–	–	0.01	0.05	–	0.14	–	0.12	0.07
16, . . .	–	–	–	–	–	–	–	–	–	–
17, . . .	–	–	–	–	–	–	–	–	–	–
18, . . .	0.06	0.10	0.13	0.05	0.05	–	0.09	0.03	0.02	0.02
19, . . .	–	–	0.18	–	–	–	–	–	–	–
20, . . .	–	*	0.17	*	*	*	*	*	*	–
21, . . .	0.42	0.50	0.15	0.48	0.42	0.24	0.25	0.22	0.19	0.29
22, . . .	0.04	–	–	–	–	–	–	0.03	–	0.01
23, . . .	–	–	–	–	–	–	–	–	–	–
24, . . .	0.01	–	–	–	–	–	–	–	–	–
25, . . .	–	–	–	–	–	–	–	–	–	–
26, . . .	–	–	–	–	–	–	–	–	–	–
27, . . .	–	–	–	–	–	–	–	–	–	–
28, . . .	–	–	–	–	–	–	–	–	–	–
29, . . .	–	–	–	–	–	–	–	0.01	–	–
30, . . .	–	–	–	–	–	–	–	–	–	–
Totals, . .	3.33	3.11	3.17	3.56	2.58	2.44	3.44	3.23	2.35	2.77

* Precipitation included in that of following day.

Daily Rainfall at Ten Places in Massachusetts, Geographically Selected. May, 1888.

Day of Month.	Deerfield.	Ludlow.	Gilbertville.	Fitchburg.	Framingham.	Chestnut Hill, Boston.	Lawrence.	Salem.	Taunton.	New Bedford.
1, . . .	0.07	0.05	0.07	*	*	*	*	0.01	0.12	*
2, . . .	0.05	0.03	0.04	0.23	0.12	0.06	0.11	–	0.03	0.06
3, . . .	–	–	–	–	–	–	–	–	–	–
4, . . .	–	–	–	–	*	–	*	*	–	–
5, . . .	0.03	0.07	0.11	–	0.13	0.24	0.06	0.16	0.38	0.35
6, . . .	–	–	–	–	–	–	–	–	–	–
7, . . .	–	–	–	–	–	–	–	–	–	–
8, . . .	–	0.02	–	–	*	*	*	*	–	*
9, . . .	0.19	0.50	0.45	0.09	0.46	0.57	0.56	0.43	0.33	0.16
10, . . .	0.06	0.10	0.09	0.07	*	–	*	–	0.03	0.04
11, . . .	*	0.05	0.34	0.12	*	0.49	0.20	0.17	0.16	*
12, . . .	1.38	1.00	*	1.49	*	1.62	1.38	2.11	1.30	1.84
13, . . .	0.05	0.15	*	0.36	2.18	1.32	0.38	1.05	0.14	0.02
14, . . .	0.08	0.40	*	–	*	0.03	0.07	0.02	0.06	0.05
15, . . .	0.81	0.20	*	0.26	0.34	0.23	*	0.06	0.21	0.11
16, . . .	0.02	0.05	–	–	–	–	0.42	0.09	–	–
17, . . .	0.06	–	–	–	–	–	–	–	–	0.01
18, . . .	0.15	0.30	*	–	*	*	*	*	0.12	*
19, . . .	0.31	0.60	2.03	0.21	0.33	0.30	0.23	0.28	0.70	0.91
20, . . .	–	–	–	–	–	–	–	–	–	–
21, . . .	–	–	–	–	–	–	–	–	–	–
22, . . .	–	–	–	–	–	–	–	–	–	–
23, . . .	–	–	–	–	–	–	–	–	–	–
24, . . .	–	–	0.04	–	–	–	–	0.02	–	0.05
25, . . .	0.01	–	–	–	–	–	–	–	–	0.42
26, . . .	–	0.02	–	–	–	–	–	–	0.30	–
27, . . .	0.03	–	*	0.06	–	–	–	–	0.18	0.22
28, . . .	0.13	0.40	*	*	–	*	*	*	0.28	*
29, . . .	0.92	0.67	*	0.86	–	0.85	0.71	0.56	0.42	0.80
30, . . .	0.17	0.10	1.09	0.05	0.83	0.10	0.12	0.12	0.16	0.68
31, . . .	–	0.05	–	–	0.11	0.09	–	0.02	0.03	0.23
Totals, . .	4.52	4.76	4.26	3.80	4.50	5.90	4.24	5.10	4.95	5.95

* Precipitation included in that of following day.

Daily Rainfall at Ten Places in Massachusetts, Geographically Selceted.
June, 1888.

Day of Month.	Deerfield.	Ludlow.	Gilbertville.	Fitchburg.	Framingham.	Chestnut Hill, Boston.	Lawrence.	Salem.	Taunton.	New Bedford.
1, . . .	0.01	–		–	–	–	–	–	0.05	–
2, . . .	–	–		–	–	–	–	–	–	–
3, . . .	–	–		–	–	–	–	–	–	–
4, . . .	–	–		–	–	–	–	–	–	–
5, . . .	–	–		–	–	–	–	–	–	–
6, . . .	–	–		0.08	0.05	*	0.15	0.13	–	–
7, . . .	0.14	0.35		0.69	–	0.14	0.17	–	0.33	–
8, . . .	0.03	0.25		–	–	–	–	–	–	–
9, . . .	–	–		–	–	–	–	–	–	–
10, . . .	–	–		–	–	–	–	–	–	–
11, . . .	–	0.05		–	0.11	–	0.05	0.13	–	–
12, . . .	–	–		–	–	–	–	–	–	–
13, . . .	–	–		–	–	–	–	–	–	–
14, . . .	0.86	0.40		0.71	0.64	0.78	0.65	0.76	0.60	0.04
15, . . .	0.35	0.55	No record.	0.19	0.22	0.35	0.12	0.19	0.08	0.21
16, . . .	0.01	–		0.12	–	–	–	–	–	0.03
17, . . .	–	–		–	–	–	–	–	–	–
18, . . .	–	–		–	0.01	–	–	–	–	–
19, . . .	–	–		–	–	–	–	–	–	–
20, . . .	0.07	0.02		0.18	0.17	0.11	0.14	0.06	0.06	0.02
21, . . .	0.75	0.22		0.12	0.08	0.03	0.11	–	0.05	0.05
22, . . .	0.01	–		–	–	–	–	–	–	0.02
23, . . .	0.13	0.55		–	0.07	0.06	0.15	0.05	–	–
24, . . .	1.96	1.00		0.43	–	–	*	–	–	–
25, . . .	0.59	–		–	0.17	–	0.22	–	–	0.02
26, . . .	0.29	0.35		0.56	0.42	0.77	0.66	0.36	0.33	0.22
27, . . .	–	–		–	–	–	–	–	–	–
28, . . .	–	–		–	*	–	–	0.01	–	–
29, . . .	0.20	0.12		0.11	0.06	–	0.07	–	0.03	0.08
30, . . .	0.02	0.02		1.17	0.80	0.34	–	0.04	0.10	0.31
Totals, . .	5.42	3.88	–	4.36	2.80	2.58	2.49	1.73	1.63	1.00

* Precipitation included in that of following day.

Daily Rainfall at Ten Places in Massachusetts, Geographically Selected. July, 1888.

Day of Month.	Deerfield.	Ludlow.	Gilbertville.	Fitchburg.	Framingham.	Chestnut Hill, Boston.	Lawrence.	Salem.	Taunton.	New Bedford.
1, . . .	0.13	0.40	0.08	0.08	0.06	-	0.05	-	0.12	0.02
2, . . .	0.02	-	0.02	-	-	-	-	-	-	-
3, . . .	-	-	-	-	-	-	-	-	-	-
4, . . .	-	-	-	-	-	-	-	-	-	-
5, . . .	0.02	0.50	0.58	-	0.03	-	-	-	0.02	0.02
6, . . .	-	-	-	-	-	-	-	-	-	-
7, . . .	-	-	-	-	-	-	-	-	-	-
8, . . .	0.04	-	-	-	-	-	-	-	-	-
9, . . .	-	0.10	-	-	-	-	-	-	0.02	0.04
10, . . .	-	-	-	-	-	-	-	-	-	-
11, . . .	0.28	0.20	*	0.47	0.08	0.22	*	0.19	-	0.65
12, . . .	-	-	0.27	-	-	-	0.67	-	0.40	-
13, . . .	-	-	-	-	-	-	-	-	-	0.01
14, . . .	-	-	-	-	-	-	-	-	-	-
15, . . .	-	-	-	-	-	-	-	-	-	-
16, . . .	-	-	-	-	-	-	-	-	-	-
17, . . .	-	-	-	-	-	-	-	-	-	-
18, . . .	-	-	-	-	-	-	-	-	-	-
19, . . .	0.66	1.00	0.87	*	*	-	*	*	*	-
20, . . .	-	0.15	0.40	0.97	0.42	0.60	1.07	0.22	0.98	0.49
21, . . .	-	-	-	-	-	-	-	-	-	0.02
22, . . .	0.03	-	-	0.10	0.61	0.70	0.58	1.04	1.12	2.93
23, . . .	-	-	0.17	0.17	0.02	0.16	-	0.09	-	-
24, . . .	0.02	-	-	-	-	-	-	-	0.12	-
25, . . .	-	-	-	-	-	-	-	-	-	-
26, . . .	-	-	-	-	-	-	-	-	-	-
27, . . .	0.20	0.25	0.13	0.12	0.08	0.10	0.10	0.04	0.36	0.27
28, . . .	0.01	-	-	-	-	-	0.04	-	0.04	0.02
29, . . .	0.01	-	-	-	0.01	0.06	-	-	0.18	0.20
30, . . .	-	-	-	-	-	-	-	-	-	-
31, . . .	-	0.25	0.11	0.03	0.28	0.14	0.31	0.38	0.04	-
Totals, . .	1.42	2.85	2.63	1.94	1.59	1.98	2.82	1.96	3.40	4.67

* Precipitation included in that of following day.

Daily Rainfall at Ten Places in Massachusetts, Geographically Selected.
August, 1888.

Day of Month.	Deerfield.	Ludlow.	Gilbertville.	Fitchburg.	Framingham.	Chestnut Hill, Boston.	Lawrence.	Salem.	Taunton.	New Bedford.
1, . . .	0.47	0.25	0.55	0.47	–	0.18	–	–	0.07	0.04
2, . . .	–	–	–	–	–	–	–	–	–	–
3, . . .	–	–	–	–	–	–	–	–	–	–
4, . . .	–	0.05	0.15	–	–	–	0.02	–	0.07	0.01
5, . . .	0.02	0.03	0.33	–	–	–	0.04	*	0.01	0.24
6, . . .	–	1.00	0.23	*	1.70	1.17	*	0.08	0.42	–
7, . . .	0.11	0.05	0.34	0.98	–	–	0.89	1.04	–	0.48
8, . . .	0.04	0.02	–	0.04	–	–	0.03	–	–	0.02
9, . . .	0.02	–	–	0.08	–	–	–	–	0.03	–
10, . . .	–	–	–	–	–	–	–	–	–	–
11, . . .	0.05	–	–	–	–	–	–	–	–	–
12, . . .	0.88	0.60	0.56	0.55	*	1.73	*	0.06	–	0.02
13, . . .	1.31	0.35	0.53	1.30	1.59	0.07	1.27	1.89	1.04	0.69
14, . . .	–	–	–	–	–	–	–	–	–	–
15, . . .	–	0.06	–	–	0.06	–	–	–	–	–
16, . . .	–	–	–	–	–	–	–	–	–	–
17, . . .	0.30	*	0.75	0.10	0.30	0.51	0.65	0.03	0.18	0.03
18, . . .	–	0.25	–	–	–	–	–	0.06	–	–
19, . . .	–	–	–	–	–	–	–	–	–	–
20, . . .	–	–	–	–	–	–	–	–	–	–
21, . . .	–	0.40	*	*	*	*	*	*	*	*
22, . . .	0.90	1.10	1.50	1.49	3.12	3.44	1.29	2.73	2.07	2.47
23, . . .	–	–	–	–	–	–	–	–	–	–
24, . . .	–	–	–	–	–	–	–	–	–	–
25, . . .	–	–	–	–	–	–	–	–	–	–
26, . . .	–	–	–	–	–	–	–	–	–	–
27, . . .	–	–	–	–	–	–	0.05	–	0.14	1.02
28, . . .	–	–	–	–	–	–	–	–	–	–
29, . . .	–	–	–	–	–	–	–	–	–	–
30, . . .	–	–	–	–	–	–	–	–	–	–
31, . . .	–	–	–	–	0.09	–	–	–	–	–
Totals, . .	4.10	4.16	4.94	5.01	6.86	7.10	4.24	5.89	4.03	5.02

* Precipitation included in that of following day.

Daily Rainfall at Ten Places in Massachusetts, Geographically Selected.
September, 1888.

Day of Month.	Deerfield.	Ludlow.	Gilbertville.	Fitchburg.	Framingham.	Chestnut Hill, Boston.	Lawrence.	Salem.	Taunton.	New Bedford.
1, ...	0.68	1.10	1.15	1.04	0.24	0.22	0.34	0.11	0.47	0.30
2, ...	–	–	–	–	–	–	–	–	0.04	0.20
3, ...	–	–	–	–	–	–	–	–	–	–
4, ...	–	–	–	0.01	–	–	–	–	0.12	0.21
5, ...	–	–	–	–	–	–	–	–	–	–
6, ...	–	–	–	–	–	–	–	–	–	–
7, ...	–	–	–	–	–	–	–	–	–	–
8, ...	0.95	2.00	2.15	2.22	0.92	0.66	*	0.78	*	–
9, ...	0.02	0.15	–	–	0.87	1.35	1.61	0.20	*	0.66
10, ...	–	–	–	–	–	–	–	–	1.40	0.96
11, ...	–	–	–	–	–	–	–	*	–	–
12, ...	0.20	0.40	–	0.40	0.60	0.59	0.72	0.63	0.28	0.35
13, ...	–	–	–	–	0.05	0.07	–	0.04	0.06	0.17
14, ...	–	–	–	–	–	–	–	–	–	–
15, ...	–	–	–	–	–	–	–	–	–	–
16, ...	–	*	0.46	*	*	0.08	*	*	*	0.80
17, ...	0.46	0.12	0.26	0.16	*	*	0.13	*	*	*
18, ...	2.90	2.00	1.92	2.29	1.87	1.94	*	*	1.43	1.13
19, ...	0.01	–	–	–	–	–	1.46	1.82	–	*
20, ...	–	0.40	–	*	–	–	*	–	–	0.20
21, ...	2.47	1.62	2.29	2.54	1.42	0.24	*	*	*	–
22, ...	0.06	–	0.04	0.14	*	0.78	1.56	1.12	0.57	0.49
23, ...	–	–	–	–	0.05	–	–	–	0.02	0.29
24, ...	–	–	–	–	–	–	–	–	–	–
25, ...	–	–	*	–	*	–	–	–	–	*
26, ...	1.06	1.50	1.57	1.77	2.97	3.50	1.92	3.26	4.33	4.95
27, ...	0.02	–	–	–	–	–	–	–	–	0.14
28, ...	–	–	–	–	–	0.02	–	0.01	0.07	0.80
29, ...	–	–	–	–	–	–	–	–	–	–
30, ...	–	0.05	–	–	–	–	–	–	–	–
Totals, . .	8.83	9.34	9.84	10.57	8.99	9.45	7.74	7.97	8.79	11.56

* Precipitation included in that of following day.

Daily Rainfall at Ten Places in Massachusetts, Geographically Selected.
October, 1888.

Day of Month.	Deerfield.	Ludlow.	Gilbertville.	Fitchburg.	Framingham.	Chestnut Hill, Boston.	Lawrence.	Salem.	Taunton,	New Bedford.
1, . . .	–	0.60	0.50	*	*	*	*	*	*	0.19
2, . . .	1.23	0.42	0.57	1.13	0.73	0.70	1.06	0.60	0.25	0.01
3, . . .	–	0.10	–	–	–	–	–	0.31	0.01	–
4, . . .	–	–	–	–	–	–	–	–	–	–
5, . . .	–	–	–	–	–	–	–	*	0.01	0.02
6, . . .	0.14	0.15	0.52	*	*	0.82	*	*	*	0.02
7, . . .	1.16	0.80	0.48	1.32	1.76	0.42	1.81	1.51	1.78	0.54
8, . . .	–	–	–	–	–	–	–	–	–	–
9, . . .	0.03	0.05	0.04	0.02	0.02	–	–	–	–	–
10, . . .	–	–	–	–	–	–	–	–	–	–
11, . . .	–	–	–	–	–	–	–	–	–	–
12, . . .	0.19	0.15	0.09	*	*	*	*	*	*	0.09
13, . . .	0.32	0.17	0.08	0.40	0.26	0.30	0.27	*	0.12	–
14, . . .	0.34	0.32	0.18	0.24	0.15	0.13	0.11	0.37	0.05	0.12
15, . . .	–	–	–	–	–	–	–	–	–	–
16, . . .	0.03	0.10	0.16	0.14	*	–	*	0.04	0.06	0.04
17, . . .	0.83	0.60	0.34	0.43	0.20	0.16	0.73	0.10	–	–
18, . . .	0.01	–	–	–	–	–	–	–	–	–
19, . . .	–	0.02	–	*	*	*	*	0.47	–	–
20, . . .	0.21	0.70	0.54	0.27	0.56	0.44	0.33	–	0.76	0.81
21, . . .	–	–	–	–	–	–	–	–	–	–
22, . . .	–	–	–	–	–	–	–	–	–	–
23, . . .	0.04	0.01	–	–	–	*	–	–	*	–
24, . . .	0.76	0.80	0.92	0.82	0.96	0.97	0.90	0.99	0.88	0.66
25, . . .	–	–	–	–	–	–	–	–	–	–
26, . . .	–	–	–	–	*	0.06	*	*	*	0.04
27, . . .	0.15	0.08	0.12	*	*	0.47	*	0.05	0.05	0.01
28, . . .	0.55	0.58	0.38	0.52	*	0.07	0.54	0.42	0.72	0.49
29, . . .	0.32	–	0.22	0.11	0.65	–	0.17	0.08	–	0.03
30, . . .	–	–	–	–	–	–	–	–	–	–
31, . . .	–	–	–	–	–	–	–	–	–	–
Totals, . .	6.31	5.65	5.14	5.40	5.29	4.54	5.92	4.94	4.69	3.07

* Precipitation included in that of following day.

Daily Rainfall at Ten Places in Massachusetts, Geographically Selected. November, 1888.—

Day of Month.	Deerfield.	Ludlow.	Gilbertville.	Fitchburg.	Framingham.	Chestnut Hill, Boston.	Lawrence.	Salem.	Taunton.	New Bedford.
1, . . .	–	–	–	–	–	–	–	–	–	–
2, . . .	–	–	–	–	–	–	–	–	–	–
3, . . .	0.17	0.30	0.33	0.15	0.10	0.07	0.10	0.06	0.14	0.02
4, . . .	–	–	–	–	–	–	–	–	–	–
5, . . .	–	–	–	–	–	–	–	–	–	–
6, . . .	–	–	–	–	–	–	–	–	0.04	0.17
7, . . .	–	–	–	–	–	–	–	–	–	0.01
8, . . .	*	0.03	–	*	*	0.20	*	*	*	0.14
9, . . .	0.67	0.45	0.48	*	*	0.05	0.54	*	0.20	0.97
10, . . .	0.75	1.75	1.53	1.87	1.86	1.55	1.02	1.25	2.50	0.86
11, . . .	0.32	0.05	0.06	–	–	–	–	–	–	–
12, . . .	–	–	–	–	–	–	–	–	–	–
13, . . .	–	–	–	–	–	–	–	–	–	–
14, . . .	–	–	–	–	–	–	–	–	–	–
15, . . .	1.15	0.90	0.66	0.91	0.84	0.95	*	0.69	0.92	0.87
16, . . .	0.01	0.10	0.13	*	*	*	0.73	0.14	0.28	0.22
17, . . .	–	–	0.05	0.04	0.23	0.19	0.14	–	–	–
18, . . .	–	–	–	–	–	–	–	–	–	–
19, . . .	0.50	0.40	0.44	0.40	0.45	0.40	0.37	0.36	0.77	0.78
20, . . .	–	–	–	–	–	–	–	–	–	–
21, . . .	–	–	–	–	–	–	–	–	–	–
22, . . .	–	–	–	–	–	–	–	–	–	–
23, . . .	–	–	–	–	–	–	–	–	–	–
24, . . .	–	–	–	–	–	–	–	*	–	–
25, . . .	*	*	*	*	*	*	*	*	*	*
26, . . .	0.27	0.60	*	*	*	*	*	*	3.23	3.11
27, . . .	0.21	0.27	1.50	2.73	3.86	4.50	3 18	3.95	1.05	–
28, . . .	0.02	–	–	–	–	–	–	–	–	–
29, . . .	0.27	0.20	–	0.18	0.30	0.26	*	–	*	0.09
30, . . .	0.02	0.03	–	–	–	–	0.08	0.18	0.12	–
Totals, . .	4.36	5.08	5.18	6.28	7.64	8.17	6.16	6.63	9.25	7.24

* Precipitation included in that of following day.

Daily Rainfall at Ten Places in Massachusetts, Geographically Selected. December, 1888.

Day of Month.	Deerfield.	Ludlow.	Gilbertville.	Fitchburg.	Framingham.	Chestnut Hill. Boston.	Lawrence.	Salem.	Taunton.	New Bedford.
1, . . .	–	–	–	–	–	–	0.04	–	–	0.01
2, . . .	–	–	–	–	–	–	–	–	–	–
3, . . .	–	–	–	–	–	–	–	–	–	–
4, . . .	0.05	0.05	0.14	0.03	–	0.02	–	0.18	–	–
5, . . .	–	–	0.02	0.01	*	0.02	–	–	–	–
6, . . .	0.01	–	–	–	0.06	–	–	–	–	0.03
7, . . .	–	–	–	–	–	–	–	–	–	–
8, . . .	–	–	–	–	*	*	–	–	–	–
9, . . .	*	0.55	0.54	0.63	0.73	0.63	0.39	0.46	0.60	0.48
10, . . .	0.75	–	*	–	–	–	–	–	*	–
11, . . .	0.10	0.55	0.57	0.86	0.51	0.99	0.52	1.09	1.26	1.61
12, . . .	–	–	–	–	–	–	–	–	–	–
13, . . .	–	–	–	–	–	–	–	–	–	–
14, . . .	–	–	–	–	–	–	–	–	–	–
15, . . .	–	–	–	–	–	–	–	–	–	–
16, . . .	*	–	–	–	–	–	–	–	*	–
17, . . .	*	2.70	2.30	2.02	*	*	*	*	*	–
18, . . .	2.30	0.75	1.20	1.42	4.02	3.51	3.58	3.54	1.66	1.04
19, . . .	–	–	–	–	–	–	–	–	–	–
20, . . .	–	–	–	–	–	–	–	–	–	–
21, . . .	–	–	–	–	0.02	–	–	–	–	–
22, . . .	–	–	–	–	–	–	–	–	–	–
23, . . .	–	–	–	–	–	–	–	–	–	–
24, . . .	–	–	–	–	–	–	–	–	–	–
25, . . .	–	–	–	–	–	–	–	–	–	–
26, . . .	–	–	–	–	–	–	–	–	–	0.01
27, . . .	0.47	0.50	0.45	0.39	0.27	0.19	0.24	0.23	0.44	0.31
28, . . .	–	–	–	–	–	–	–	–	–	–
29, . . .	–	–	–	–	–	–	–	–	–	–
30, . . .	–	–	–	–	–	–	–	–	–	–
31, . . .	–	–	–	–	–	.	–	–	0.01	0.01
Totals, . .	3.68	5.10	5.22	5.36	5.61	5.36	4.77	5.50	3.97	3.50

* Precipitation included in that of following day.

Daily Rainfall at Ten Places in Massachusetts, Geographically Selected. January, 1889.

Day of Month.	Deerfield.	Ludlow.	Gilbertville.	Fitchburg.	Framingham.	Chestnut Hill, Boston.	Lawrence.	Salem.	Taunton.	New Bedford.
1, . . .	–	–	–	–	–	–	–	–	–	–
2, . . .	–	–	–	–	–	–	–	–	–	–
3, . . .	–	–	–	–	–	–	–	–	–	–
4, . . .	–	–	–	–	–	–	–	–	–	–
5, . . .	0.03	0.01	–	–	–	–	–	–	–	–
6, . . .	0.56	0.30	0.26	0.67	*	*	–	*	2.25	*
7, . . .	0.38	0.25	0.27	0.59	2.69	4.06	2.17	2.98	0.48	2.56
8, . . .	–	–	–	–	–	–	–	–	–	–
9, . . .	0.93	0.85	0.53	0.55	*	*	–	*	1.15	0.60
10, . . .	0.08	0.15	0.10	0.03	0.59	0.45	–	0.24	–	–
11, . . .	–	–	–	–	–	–	0.43	–	–	–
12, . . .	–	–	–	–	–	–	–	–	–	–
13, . . .	–	–	–	–	–	–	–	–	–	–
14, . . .	–	–	–	–	–	–	–	–	–	–
15, . . .	–	–	–	–	–	–	–	–	–	–
16, . . .	0.03	0.02	0.11	0.02	–	*	–	*	–	–
17, . . .	0.99	1.05	1.43	1.34	0.62	0.52	0.66	0.33	0.60	1.10
18, . . .	–	–	–	–	–	–	–	–	–	–
19, . . .	–	–	–	–	–	–	–	–	–	–
20, . . .	*	*	*	0.02	–	*	–	–	–	–
21, . . .	0.35	0.42	1.48	1.39	*	0.61	1.31	0.98	0.94	0.93
22, . . .	–	–	–	–	0.61	–	–	–	–	–
23, . . .	–	–	–	–	–	–	–	–	–	–
24, . . .	0.01	–	–	–	–	–	–	–	–	0.04
25, . . .	–	–	–	–	–	–	–	–	0.02	–
26, . . .	–	–	–	–	–	–	–	–	–	–
27, . . .	–	0.60	0.55	1.00	0.85	0.86	0.58	*	*	0.62
28, . . .	0.65	0.30	–	0.10	–	–	0.03	0.70	0.70	–
29, . . .	–	0.02	–	0.01	–	–	–	–	0.01	–
30, . . .	–	–	–	–	–	–	–	–	–	–
31, . . .	–	–	–	0.01	0.03	–	0.03	–	–	0.06
Totals, . .	4.01	3.97	4.73	5.73	5.39	6.50	5.21	5.23	6.15	5.91

* Precipitation included in that of following day.

Daily Rainfall at Ten Places in Massachusetts, Geographically Selected.
February, 1889.

Day of Month.	Deerfield.	Ludlow.	Gilbertville.	Fitchburg.	Framingham.	Chestnut Hill, Boston.	Lawrence.	Salem.	Taunton.	New Bedford.
1, . . .	–	–	–	–	–	–	–	–	–	–
2, . . .	–	–	–	–	–	–	–	–	–	–
3, . . .	–	0.01	–	0.01	0.01	–	–	–	–	–
4, . . .	–	–	–	–	–	–	–	–	–	–
5, . . .	0.03	0.05	–	0.15	*	0.48	0.28	*	0.62	–
6, . . .	–	0.20	0.05	0.22	0.27	–	0.08	0.52	–	0.72
7, . . .	0.30	–	–	–	–	–	–	–	–	–
8, . . .	–	–	–	–	*	*	–	–	*	–
9, . . .	–	0.10	0.22	0.05	0.11	0.13	0.05	0.10	0.26	0.45
10, . . .	–	–	–	–	–	–	–	–	–	–
11, . . .	–	–	–	0.02	*	*	–	*	*	0.20
12, . . .	0.16	0.20	0.23	0.34	0.23	0.34	0.44	0.49	0.26	–
13, . . .	–	–	–	–	–	–	–	–	–	–
14, . . .	–	–	–	–	–	–	–	–	–	–
15, . . .	–	–	–	–	–	–	–	–	–	–
16, . . .	*	0.20	–	0.09	*	*	–	*	*	–
17, . . .	0.38	0.35	–	0.26	0.44	0.36	0.41	0.47	0.35	0.64
18, . . .	0.45	0.50	*	0.46	0.57	0.58	0.34	0.46	0.65	0.65
19, . . .	0.15	0.05	0.45	0.03	–	–	–	–	–	–
20, . . .	–	–	–	–	–	–	–	–	–	–
21, . . .	–	–	–	–	–	–	–	–	–	–
22, . . .	–	–	–	–	–	–	–	–	–	0.01
23, . . .	–	–	–	–	–	–	–	–	–	–
24, . . .	–	–	–	–	–	–	–	–	–	–
25, . . .	–	0.01	–	–	–	–	–	–	0.08	0.07
26, . . .	–	–	*	–	–	–	–	–	–	–
27, . . .	0.25	0.20	0.18	0.08	0.02	0.04	–	0.03	–	0.01
28, . . .	0.70	0.10	–	0.01	–	–	0.05	–	–	–
Totals, . .	2.42	1.97	1.13	1.72	1.65	1.93	1.65	2.07	2.22	2.75

* Precipitation included in that of following day.

Daily Rainfall at Ten Places in Massachusetts, Geographically Selected.
March, 1889.

Day of Month.	Deerfield.	Ludlow.	Gilbertville.	Fitchburg.	Framingham.	Chestnut Hill, Boston.	Lawrence.	Salem.	Taunton.	New Bedford.
1, . . .	–	–	–	–	–	–	–	–	–	–
2, . . .	–	–	–	–	–	–	–	–	–	–
3, . . .	–	–	–	–	–	–	–	–	–	–
4, . . .	–	–	–	–	*	–	–	–	–	–
5, . . .	0.15	0.50	0.50	0.48	*	*	–	*	*	–
6, . . .	0.45	0.50	0.55	0.45	*	*	–	0.73	0.68	0.90
7, . . .	–	0.05	0.21	0.07	1.10	1.03	1.48	–	0.07	–
8, . . .	–	–	–	–	–	–	–	–	–	–
9, . . .	–	–	–	–	–	–	–	–	–	–
10, . . .	–	–	–	–	–	–	–	–	–	–
11, . . .	–	–	–	–	–	–	–	–	–	–
12, . . .	–	–	–	–	–	–	–	–	–	–
13, . . .	–	–	–	–	–	–	–	–	–	–
14, . . .	–	–	–	–	–	–	–	–	–	–
15, . . .	–	–	–	–	–	–	–	–	–	–
16, . . .	0.12	–	–	*	*	*	–	*	*	–
17, . . .	0.11	0.12	–	0.14	*	*	–	*	*	–
18, . . .	–	0.12	0.40	0.25	*	0.56	0.39	0.50	0.67	0.62
19, . . .	–	–	–	0.03	0.59	–	0.03	–	–	–
20, . . .	–	*	–	–	–	–	–	–	0.18	–
21, . . .	–	0.05	–	–	–	–	–	–	–	0.42
22, . . .	–	–	–	–	–	–	–	–	–	–
23, . . .	–	–	–	–	–	–	–	–	–	–
24, . . .	–	–	–	–	–	–	–	–	–	–
25, . . .	–	–	–	–	–	–	–	–	–	–
26, . . .	–	–	–	–	–	–	–	–	–	–
27, . . .	–	–	–	–	*	–	–	–	–	0.13
28, . . .	0.07	0.30	0.33	0.15	0.14	0.15	0.13	0.02	0.23	0.05
29, . . .	0.07	–	–	–	–	–	–	0.13	–	–
30, . . .	–	0.15	0.12	0.08	0.03	0.03	–	*	0.13	–
31, . . .	0.50	0.30	0.78	0.29	0.60	0.40	–	0.28	0.30	0.57
Totals, . .	1.47	2.09	2.89	1.94	2.46	2.17	2.03	1.66	2.26	2.69

* Precipitation included in that of following day.

Daily Rainfall at Ten Places in Massachusetts, Geographically Selected. April, 1889.

Day of Month.	Deerfield.	Ludlow.	Gilbertville.	Fitchburg.	Framingham.	Chestnut Hill, Boston.	Lawrence.	Salem.	Taunton.	New Bedford.
1, . . .	0.83	0.60	*	0.83	*	*	–	*	*	*
2, . . .	0.32	0.36	0.50	0.18	0.85	1.04	1.36	1.18	1.28	0.69
3, . . .	0.10	0.10	–	0.05	0.04	0.05	0.05	0.04	0.09	0.04
4, . . .	–	–	–	–	–	–	–	–	–	–
5, . . .	–	–	–	–	–	–	–	–	0.02	–
6, . . .	–	–	–	–	–	–	0.13	–	–	–
7, . . .	–	–	–	–	–	–	–	–	–	–
8, . . .	–	–	–	–	–	–	–	–	–	–
9, . . .	–	–	–	–	–	–	–	–	–	0.07
10, . . .	–	–	–	–	–	–	–	–	–	–
11, . . .	–	–	–	–	–	–	–	–	–	0.21
12, . . .	0.01	0.07	0.11	–	0.04	*	–	*	0.45	0.06
13, . . .	–	0.13	0.09	–	0.14	0.31	0.07	0.14	0.31	0.28
14, . . .	–	–	–	–	–	–	–	*–	–	–
15, . . .	–	–	–	–	–	–	–	–	–	–
16, . . .	–	–	–	–	–	–	–	–	–	–
17, . . .	–	–	–	0.02	*	*	–	*	0.85	0.99
18, . . .	–	0.02	–	0.12	0.59	0.66	–	0.56	–	0.12
19, . . .	–	–	–	–	–	–	0.33	–	–	–
20, . . .	0.04	0.15	0.04	0.10	*	0.21	0.10	0.10	–	0.01
21, . . .	–	–	0.08	0.02	0.30	0.03	0.03	0.02	0.05	–
22, . . .	–	–	–	–	–	–	–	–	–	–
23, . . .	–	–	–	–	–	–	–	–	–	–
24, . . .	–	–	–	–	–	–	–	–	–	–
25, . . .	*	–	–	0.05	*	0.03	–	–	0.05	0.04
26, . . .	0.45	0.10	0.64	1.05	0.03	*	–	*	1.33	1.54
27, . . .	0.90	1.05	0.40	0.64	–	*	1.78	1.46	0.17	0.10
28, . . .	0.24	0.10	0.17	0.06	1.60	1.66	0.20	0.10	0.02	0.01
29, . . .	0.01	0.05	–	–	–	0.03	0.07	–	–	0.06
30, . . .	–	–	–	–	–	–	–	–	–	–
Totals, . .	2.90	2.73	2.03	3.12	3.59	4.02	4.12	3.60	4.62	4.22

* Precipitation included in that of following day.

Daily Rainfall at Ten Places in Massachusetts, Geographically Selected.
May, 1889.

Day of Month.	Deerfield.	Ludlow.	Gilbertville.	Fitchburg.	Framingham.	Chestnut Hill, Boston.	Lawrence.	Salem.	Taunton.	New Bedford.
1, . . .	-	-	-	-	-	-	-	-	-	-
2, . . .	-	0.02	-	-	-	-	-	-	-	-
3, . . .	-	-	-	-	-	-	-	-	-	-
4, . . .	-	-	-	-	-	-	-	-	-	-
5, . . .	-	-	-	-	-	-	-	-	-	-
6, . . .	-	-	-	-	-	-	-	-	-	-
7, . . .	-	-	-	-	-	-	-	-	-	-
8, . . .	-	-	-	-	-	-	-	-	-	-
9, . . .	-	-	-	-	-	-	-	-	-	-
10, . . .	0.36	0.12	-	0.25	0.22	0.05	0.25	-	0.30	0.02
11, . . .	0.01	0.05	0.18	0.10	-	-	-	-	-	0.04
12, . . .	-	-	-	-	-	-	-	-	0.05	0.08
13, . . .	*	0.02	-	0.03	*	0.09	0.17	-	0.34	0.57
14, . . .	0.79	0.08	0.17	0.36	0.06	-	0.67	0.03	0.01	0.12
15, . . .	-	-	0.18	-	0.02	-	-	-	-	-
16, . . .	-	0.20	-	-	-	-	-	-	-	-
17, . . .	-	-	-	-	-	-	-	-	-	-
18, . . .	-	-	-	-	-	-	-	-	-	-
19, . . .	-	-	-	-	-	-	-	-	-	-
20, . . .	0.95	1.00	0.60	0.95	*	*	-	-	1.48	1.24
21, . . .	0.59	0.65	0.38	0.69	2.55	3.17	2.29	1.99	0.20	0.48
22, . . .	-	-	-	-	-	-	-	-	-	0.01
23, . . .	-	-	-	-	-	-	-	0.03	0.18	0.76
24, . . .	-	-	-	-	-	-	-	-	-	-
25, . . .	0.13	0.45	0.18	0.07	0.22	0.34	0.09	0.07	-	-
26, . . .	*	0.30	0.36	0.32	0.32	0.34	0.36	0.28	0.54	0.68
27, . . .	0.68	0.40	0.37	0.50	0.66	*	-	*	*	1.35
28, . . .	0.04	0.08	0.11	0.01	-	0.74	0.50	0.57	0 90	-
29, . . .	-	-	-	-	-	-	-	-	-	-
30, . . .	0.08	0.05	-	-	-	0.05	-	-	0.01	0.02
31, . . .	0.25	0.15	-	-	-	-	-	0.14	0.05	0.03
Totals, . .	3.88	3.57	2.53	3.28	4.05	4.78	4.33	3.11	4.06	5.40

* Precipitation included in that of following day.

Flow of Streams.

The unusually large flow of the streams during the two years under consideration has already been referred to, while discussing the rainfall. For the eastern portion of the State a more accurate determination of the departure from the normal flow may be obtained from the records of the flow of Sudbury River, published in the reports of the Boston Water Board. The records would in some years be applicable to the whole State, but in the summer of 1887 are not at all so, as the rainfall was then very unequally distributed, being much higher in the western portion.

The drainage area from which the flow was measured is 75.2 square miles. Within this area the city of Boston has five reservoirs, which, when full, have an aggregate area of 1.38 square miles. In estimating the flow, due allowance is made for variations in the height of the water in these reservoirs, so that the records indicate the natural flow of the stream, modified only by the storage in such reservoirs and mill ponds as are not controlled by Boston.

The city reservoirs cause the flow to be smaller than it otherwise would be during the summer months whenever the evaporation exceeds the rainfall; that is to say, in all summer months of low rainfall. The normal flow given in the following table is the average of eleven years, from 1879 to 1889 inclusive, during which time the area of evaporating surfaces has been approximately constant. The departures from the normal are given in bold-faced type: —

Table showing flow of Sudbury River from June, 1887, to May, 1889, inclusive, in cubic feet per second per square mile of drainage area, also departures from the normal flow.

MONTH.	Normal Flow.	June, 1887, to May, 1888.	Excess or Deficiency.	June, 1888, to May, 1889.	Excess or Deficiency.
June,	0.734	0.631	**−0.103**	0.644	**−0.090**
July,	0.298	0.180	**−0.118**	0.185	**−0.113**
August,	0.489	0.338	**−0.151**	0.599	**+0.110**
September,	0.442	0.169	**−0.273**	1.763	**+1.321**
October,	0.692	0.300	**−0.392**	3.153	**+2.461**
November,	1.154	0.562	**−0.592**	4.209	**+3.055**
December,	1.572	1.014	**−0.558**	4.799	**+3.227**
January,	1.996	1.660	**−0.336**	4.388	**+2.392**
February,	3.067	2.878	**−0.189**	1.703	**−1.364**
March,	3.873	5.106	**+1.233**	2.111	**−1.762**
April,	2.961	4.037	**+1.076**	2.152	**−0.809**
May,	1.639	2.574	**+0.935**	1.387	**−0.252**
Total,	18.917	19.449	**+0.532**	27.093	**+8.176**

The fluctuations in the flow of the streams during the two years from June, 1887, to May, 1889, inclusive, are illustrated by two tables and a diagram, which follow.

The first table shows the average monthly flow in cubic feet per second per square mile of drainage area of all streams measured. The flow of the Sudbury and Merrimack is the rate for the whole day; that of other streams, the rate during working hours.

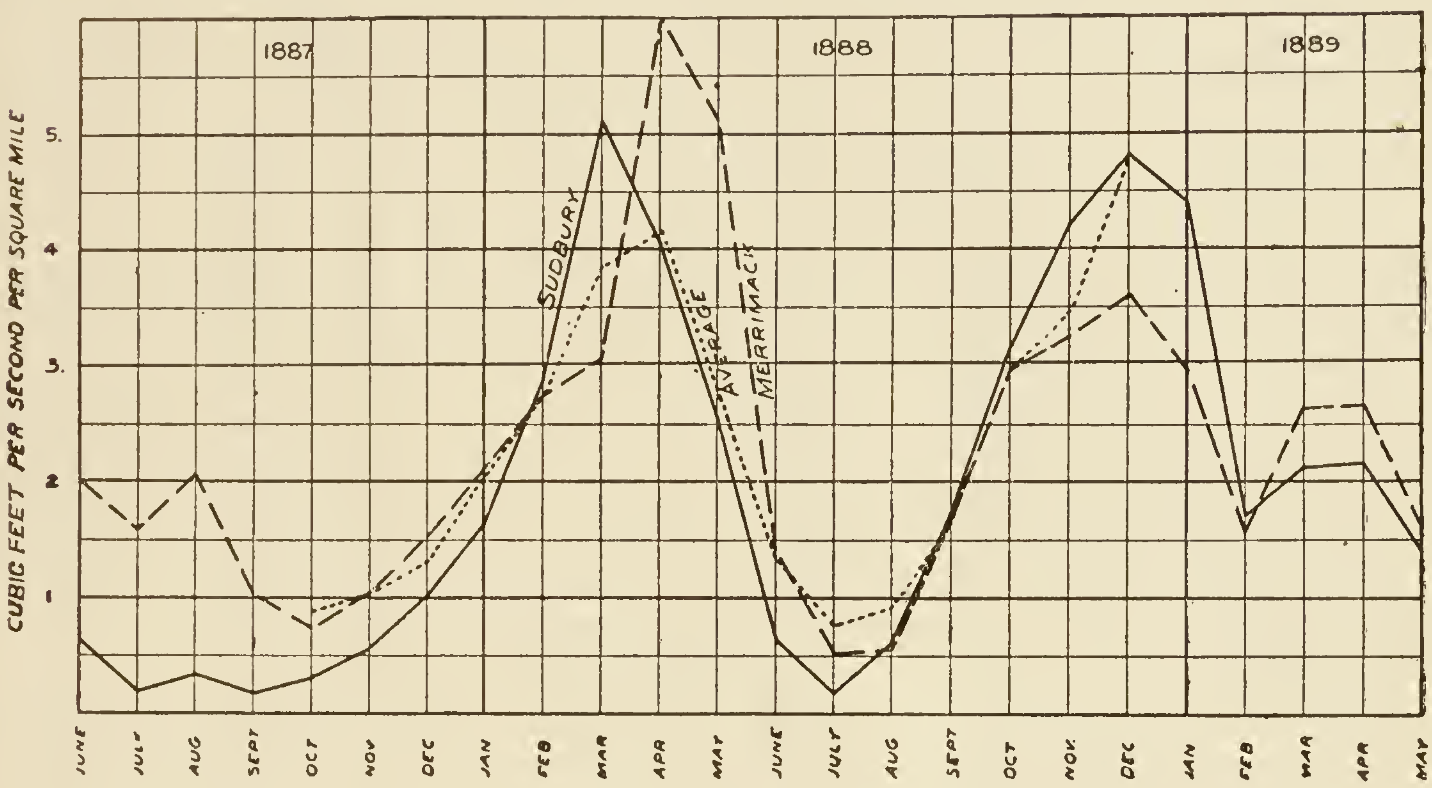
*Table showing the average monthly flow of rivers in Massachusetts, in cubic feet per second per square mile of drainage area, from June, 1887, to May, 1889.**

	Sudbury River.	Merrimack River at Lawrence.	Blackstone River at Millbury.	Blackstone River at Uxbridge.	Blackstone River at Blackstone.	Charles River at Newton Upper Falls.	Charles River at Watertown.	Chicopee River at Ludlow.	Miller's River at Orange.	Mother Brook at East Dedham.	Nashua River at Nashua.	Neponset River at Mattapan.
1887.												
June,	0.63	2.00	-	-	-	-	-	-	-	-	-	-
July,	0.18	1.62	-	-	-	-	-	-	-	-	-	-
August,	0.34	2.06	-	-	-	-	-	-	-	-	-	-
September,	0.17	1.03	-	-	-	-	-	-	-	-	-	-
October,	0.30	0.75	1.41	1.62	1.35	0.48	0.59	0.90	1.10	0.27	1.15	1.16
November,	0.56	1.05	1.23	1.43	1.36	0.62	1.03	1.05	1.26	0.41	1.38	1.12
December,	1.01	1.53	1.63	1.76	1.50	0.96	1.29	1.41	1.45	0.68	1.63	1.13
1888.												
January,	1.66	2.12	2.84	3.21	2.34	1.46	2.20	1.80	-	1.24	1.47	-
February,	2.88	2.76	3.48	4.07	-	1.98	2.95	2.62	-	1.95	2.13	-
March,	5.11	3.04	5.24	3.96	4.29	3.46	4.39	3.11	-	3.22	2.54	-
April,	4.04	6.00	4.18	3.91	4.09	3.28	4.11	4.66	-	2.87	4.06	-
May,	2.57	5.10	2.76	3.09	2.22	2.12	3.23	2.35	-	1.78	2.30	-
June,	0.64	1.40	1.98	1.92	1.40	0.84	1.62	1.13	-	0.83	1.32	-
July,	0.18	0.53	1.18	1.25	1.27	0.23	0.55	0.77	-	0.36	1.28	-
August,	0.60	0.57	1.14	1.89	1.23	0.46	0.86	0.80	-	0.38	1.33	-
September,	1.76	1.69	1.62	1.84	1.55	1.00	1.65	1.99	-	0.77	2.33	-
October,	3.15	2.95	3.02	2.54	2.46	2.13	3.24	-	-	1.81	4.82	-
November,	4.21	3.24	4.09	4.03	3.60	2.58	3.25	-	-	2.36	-	-
December,	4.80	3.60	6.32	-	5.67	4.73	4.75	-	-	4.35	3.94	-
1889.												
January,	4.39	2.94	-	-	-	-	-	-	-	-	-	-
February,	1.70	1.55	-	-	-	-	-	-	-	-	-	-
March,	2.11	2.64	-	-	-	-	-	-	-	-	-	-
April,	2.15	2.67	-	-	-	-	-	-	-	-	-	-
May,	1.39	1.64	-	-	-	-	-	-	-	-	-	-

* For the Sudbury and Merrimack Rivers the rate for the whole day is given; in other cases, the rate during working hours.

The diagram represents graphically the facts presented in the above table, except that, to avoid confusion of lines, the *average* flow of all streams excepting the Sudbury and Merrimack is given.

DIAGRAM OF FLOW OF RIVERS.



The second table, given below, shows in greater detail than the other the fluctuations in the flow of the two streams most carefully measured; namely, the Sudbury and the Merrimack. The great difference between the flow per square mile of these two streams during the summer of 1887 is mainly due to the much larger rainfall upon the watershed of the latter.

Table showing the average weekly flow of the Sudbury and Merrimack rivers, in cubic feet per second per square mile, from June, 1887, to May, 1889, inclusive.

Week Ending Sunday.	Sudbury River. Cu. ft. per sec. per sq. mile.	Merrimack River. Cu. ft. per sec. per sq. mile.	Week Ending Sunday.	Sudbury River. Cu. ft. per sec. per sq. mile.	Merrimack River. Cu. ft. per sec. per sq. mile.
1887.			**1887**—Con.		
June 5, ...	1.454	–	Aug. 7, ...	0.222	1.701
12, ...	0.722	1.927	14, ...	0.152	1.322
19, ...	0.276	0.943	21, ...	0.276	1.617
26, ...	0.409	2.312	28, ...	0.665	3.556
July 3, ...	0.132	1.851	Sept. 4, ...	0.140	1.793
10, ...	0.088	0.992	11, ...	0.208	1.228
17, ...	0.084	1.047	18, ...	0.218	1.101
24, ...	0.317	0.807	25, ...	0.123	0.768
31, ...	0.263	3.853	Oct. 2, ...	0.206	0.570

Table showing the average weekly flow of the Sudbury and Merrimack rivers, in cubic feet per second per square mile, from June, 1887, to May, 1889, inclusive — Concluded.

Week Ending Sunday.	Sudbury River. Cu. ft. per sec. per sq. mile.	Merrimack River. Cu. ft. per sec. per sq. mile.	Week Ending Sunday.	Sudbury River. Cu. ft. per sec. per sq. mile.	Merrimack River. Cu. ft. per sec. per sq. mile.
1887 — Con.			**1888** — Con.		
Oct. 9, . . .	0.152	0.921	Aug. 5, . . .	0.101	0.414
16, . . .	0.206	0.711	12, . . .	0.288	0.431
23, . . .	0.455	0.650	19, . . .	0.646	0.768
30, . . .	0.354	0.815	26, . . .	1.399	0.634
Nov. 6, . . .	0.261	0.540	Sept. 2, . . .	0.399	0.496
13, . . .	0.422	0.558	9, . . .	0.448	0.488
20, . . .	0.837	1.393	16, . . .	0.726	0.712
27, . . .	0.650	1.304	23, . . .	2.349	2.290
Dec. 4, . . .	0.578	1.499	30, . . .	4.041	3.677
11, . . .	0.755	1.257	Oct. 7, . . .	3.226	2.674
18, . . .	1.185	2.307	14, . . .	3.687	3.367
25, . . .	0.971	1.285	21, . . .	2.584	2.688
1888.			28, . . .	3.039	2.790
Jan. 1, . . .	2.142	1.420	Nov. 4, . . .	2.386	3.024
8, . . .	3.164	2.391	11, . . .	2.845	2.461
15, . . .	1.162	1.741	18, . . .	3.711	3.608
22, . . .	0.926	2.333	25, . . .	2.777	2.893
29, . . .	0.819	2.092	Dec. 2, . . .	9.221	4.978
Feb. 5, . . .	0.891	1.918	9, . . .	2.989	3.120
12, . . .	1.241	2.051	16, . . .	2.987	2.085
19, . . .	1.014	1.907	23, . . .	9.120	5.383
26, . . .	7.954	4.125	30, . . .	3.820	3.361
Mar. 4, . . .	2.714	3.841	**1889.**		
11, . . .	1.348	1.985	Jan. 6, . . .	3.482	2.553
18, . . .	1.652	1.768	13, . . .	7.162	4.125
25, . . .	10.515	3.563	20, . . .	3.813	3.260
Apr. 1, . . .	8.567	5.295	27, . . .	3.048	2.320
8, . . .	6.618	6.899	Feb. 3, . . .	2.961	1.976
15, . . .	4.576	6.074	10, . . .	1.826	1.669
22, . . .	3.028	5.384	17, . . .	1.495	1.470
29, . . .	2.117	5.218	24, . . .	2.435	1.595
May 6, . . .	1.627	7.377	Mar. 3, . . .	1.240	1.119
13, . . .	2.932	5.546	10, . . .	3.555	3.333
20, . . .	3.713	6.278	17, . . .	1.766	2.549
27, . . .	1.827	2.979	24, . . .	1.789	2.726
June 3, . . .	1.924	2.768	31, . . .	1.488	2.701
10, . . .	0.749	1.725	Apr. 7, . . .	3.005	2.653
17, . . .	0.623	1.138	14, . . .	1.701	2.726
24, . . .	0.409	0.871	21, . . .	1.667	2.474
July 1, . . .	0.457	1.157	28, . . .	2.165	2.434
8, . . .	0.278	0.682	May 5, . . .	1.895	2.861
15, . . .	0.109	0.484	12, . . .	1.007	1.483
22, . . .	0.191	0.506	19, . . .	0.615	1.151
29, . . .	0.115	0.459	26, . . .	2.108	1.858

Temperature of Air.

The temperature of the air during the year beginning June 1, 1887, was lower than the normal every month except July and December. January was very cold, and thick ice formed upon the ponds and rivers. The average temperature for the whole year was 1.6 degrees Fahrenheit, below the normal. The second year, although the temperature averaged 0.8 of a degree above the normal, was characterized by an unusually cool summer and autumn and by a warm winter. February was the only cold month, and ice then formed to a thickness of from eight to twelve inches.

The departures from the normal are given in detail in the following table, compiled from the Bulletin of the New England Meteorological Society: —

	June.	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	Mean.
Normal temperature, .	66.0	71.4	68.6	60.8	50.1	39.0	28.5	24.1	25.8	32.2	43.9	56.3	47.2
June, 1887, to May, 1888,	65.1	73.7	66.3	57.8	48.7	38.8	29.9	16.8	25.7	29.4	41.6	54.0	45.6
Excess or deficiency, .	−0.9	+2.3	−2.3	−3.0	−1.4	−0.2	+1.4	−7.3	−0.1	−2.8	−2.3	−2.3	−1.6
June, 1888, to May, 1889,	66.3	67.4	68.1	57.6	45.3	41.0	31.7	32.2	23.1	36.5	47.2	59.5	48.0
Excess or deficiency, .	+0.3	−4.0	−0.5	−3.2	−4.8	+2.0	+3.2	+8.1	−2.7	+4.3	+3.3	+3.2	+0.8

Temperature of Water.

The temperature of water is of much more importance than that of the air, because it influences directly the growth and decay of organisms which cause bad tastes and odors. It also has a marked effect upon the waters of deep ponds, at one season of the year preventing, and at another promoting, the circulation between layers of water at different depths.

In view of the importance of this subject, arrangements were made for obtaining daily records of the temperature of many of the water supplies of the State. From these records, and others kept in previous years on the Boston Water Works and at Springfield, certain important conclusions may be drawn.

The mean annual temperature of surface and ground waters is nearly the same; but the former becomes warm and cold at different seasons of the year, like the atmosphere, while the temperature of the latter is nearly constant at all times. It is therefore necessary to consider these two classes of water separately.

Temperature of Surface Waters.

Ponds and Reservoirs. — The temperature of water stored in ponds and reservoirs, when taken near the surface, is nearly the same in all parts of the State, and is independent of the depth except when the water is unusually shallow. These features are illustrated by the following table.

Table showing Comparative Temperatures of Ponds and

		Boston Water Works.				Worcester Water Works.				
	Standard.	Brookline Reservoir.	Reservoir No. 3.	Reservoir No. 4.	Springfield Water Works, Ludlow Reservoir.	Tatnuck Brook Reservoir.	Lynde Brook Reservoir.	Cambridge, Fresh Pond.*	Lynn, Tap at Pumping Station.†	Salem, Water Works, Wenham Lake.
Maximum depth, . .	23 ft.	24 ft.	21 ft.	46 ft.	24 ft.	-	37.4 ft.	46 ft.	-	47 ft.
Average depth, . .	14.2 ft	16 ft.	13 ft.	26 ft.	13.7 ft.	14.6 ft.	14.6 ft.	-	-	-
1887.										
June, ...	67.7	–1.7	+1.6	–1.2	+0.2	–0.3	–1.9	–0.2	-	-
July, ...	75.8	–1.3	+1.7	+1.1	–0.3	0.0	–2.1	+0.1	-	+2.1
August, ...	74.1	–0.5	+0.4	–1.3	0.0	–1.8	–3.3	–0.8	–1.9	–0.2
September, . . .	65.4	+0.7	–0.5	+0.6	–0.3	–2.1	–1.7	–0.5	–0.6	+0.5
October, ...	55.2	+0.6	–0.5	+0.8	0.0	–1.6	–0.9	+0.4	+1.6	+1.1
November, . . .	42.3	+0.8	–0.6	+1.4	–0.1	–2.6	–1.8	-	+2.2	-
December, . . .	36.6	+0.6	–0.9	-	+0.2	–2.8	–2.7	-	–0.6	-
1888.										
January, ...	35.8	+0.7	–2.4	-	+1.7	–1.8	–1.8	–0.7	–0.6	–1.8
February, . . .	35.8	+0.4	–2.5	-	+2.1	–1.8	–1.5	–0.8	–1.1	-
March, ...	37.1	–0.2	–2.8	-	+2.9	–3.0	–1.8	–1.6	+0.5	–2.7
April, ...	42.0	+0.7	–1.0	-	+0.2	–4.8	–3.6	–1.5	+2.5	–0.8
May, ...	55.6	–1.3	+0.8	-	+0.5	–0.5	–1.1	–4.1	–0.7	-
June, ...	69.3	–1.9	+3.1	–0.3	–1.2	+0.9	+0.3	–7.2	–4.6	-
July, ...	71.8	–0.7	+0.9	–0.1	–0.1	+0.5	–1.4	–2.1	–1.0	-
August, ...	72.8	–0.6	0.0	–1.4	+0.5	+0.4	–2.4	–2.2	+1.3	-
September, . . .	66.5	–0.2	–0.6	–0.9	+0.7	–2.1	+3.5	–1.2	+0.2	-
October, ...	51.6	+0.6	–1.1	+0.7	+0.6	–2.8	–4.2	+0.6	+1.1	-
November, . . .	45.0	+1.1	–0.6	+1.0	–0.4	-	-	-	+0.8	-
December, . . .	35.7	+0.9	–1.3	+0.1	+0.5	-	-	-	+2.5	-
1889.										
January, ...	35.7	+1.3	–1.6	-	+0.4	-	-	-	+0.1	-
February, . . .	36.2	+0.7	–0.7	0.0	0.0	-	-	-	+1.4	-
March, ...	38.4	+0.1	–1.2	-	+1.0	-	-	–1.9	+1.9	-
April, ...	47.3	0.0	+0.4	–0.9	–0.3	-	-	–2.4	-	-
May, ...	63.1	–2.5	+2.6	+0.6	–0.2	-	-	–7.1	-	-

* Temperatures taken at the pumping station.

† Water is drawn from Birch and Breed's ponds, also from the canal fed by Hawkes and Penny brooks.

The first column, used as a standard, contains an average of temperatures recorded at three reservoirs; namely, the Ludlow Reservoir of the Springfield Water Works, and Reservoir No. 3 and the Brookline Reservoir of the Boston Water Works; the other columns show departures from this standard, + indicating a higher temperature, and — a lower one.

Reservoirs in Massachusetts, from June, 1887, to May, 1889.

	Danvers, Water Works, Middleton Pond.*	Woburn, Horn Pond.	Winchester Reservoir.	Weymouth, Great Pond.*	Hingham, Accord Pond.	Abington and Rockland Water Works, Big Sandy Pond.*	Nantucket, Wannacomet, Pond.	Boston, Jamaica Pond.*	Westborough, Chauncy Pond.	Average.
Maximum depth, . .	33 ft.	-	25 ft.	-	45 ft.	20 ft.	15 ft.	57 ft.	-	-
Average depth, ...	-	-	13 ft.	abt. 12 ft.	20 ft.	-	-	27 ft.	-	-
1887.										
June, ...	-	-	+3.2	-	-	-	-	-	-	0.0
July, ...	—1.8	-	+4.0	+1.0	-	-	+1.6	-	-	+0.5
August, ...	—0.2	+0.5	+1.0	—0.6	—2.6	+2.3	—2.1	—0.3	-	—0.7
September, ...	+0.6	+0.1	+1.5	—0.2	—5.8	—1.5	—1.7	+0.7	-	—0.6
October, ...	+1.6	+1.3	-	+0.9	—3.5	+2.7	+1.7	-	-	+0.4
November, ...	+3.0	+1.4	-	+0.7	—0.9	+3.1	+5.0	-	-	+0.9
December, ...	+1.0	—1.5	-	+2.6	+1.6	+3.0	+4.4	-	-	+0.4
1888.										
January, ...	+1.2	—3.2	-	+0.2	-	—1.8	—1.1	-	-	—0.9
February, ...	+1.2	—8.7	+0.6	+0.2	-	-	+1.9	-	-	—0.4
March, ...	+0.7	—1.0	+0.8	0.0		+1.8	+0.9	-	-	—0.4
April, ...	—1.2	+2.2	—0.7	+1.8	-	+6.0	+4.5	-	+3.5	+0.5
May, ...	—2.5	+4.2	—3.3	—1.9	-	+5.5	+0.4	-	—4.9	—0.6
June, ...	—1.3	+5.2	-	-	-	+7.2	—2.0	-	+0.7	—0.1
July, ...	+0.6	+2.9	-	-	-	+4.2	-	-	-	+0.3
August, ...	—1.0	+2.4	-	-	-	+3.1	-	-	—1.9	—0.1
September, ...	—1.4	-	-	-	-	+1.9	-	-	—0.8	—0.1
October, ...	+0.4	-	-	-	-	-	-	-	—3.6	—0.8
November, ...	+1.6	-	-	-	-	-	-	-	-	+0.6
December, ...	—0.8	-	-	-	-	-	-	-	-	+0.3
1889.										
January, ...	—2.5	-	-	-	-	-	-	-	-	—0.5
February, ...	—3.9	-	-	-	-	-	-	-	-	—0.4
March, ...	0.0	-	-	-	-	-	-	-	-	0.0
April, ...	+2.6	-	-	-	-	-	-	-	-	—0.1
May, ...	+3.3	-	-	-	-	-	-	-	-	—0.5

* Temperatures taken at the pumping station.

By examining the table, it will be observed that there are a few exceptions to the rule above stated. This may be due, in some instances, to taking the temperature too near the surface, where the water is warmer in the summer and colder in the winter; and in other cases to the situation of the pond, and possibly to its depth.

There is no doubt that the water in very shallow ponds may be much warmer than in deeper ones. As an instance of this, the water of Pilling's Pond, in Lynnfield, which has an area of about 85 acres and a depth of but 4 feet, was found, by observations on five days in July and August, 1889, to range from 3 to 6 degrees warmer than the water of ordinary ponds. On the other hand, the water of this pond on the 23d of September was 3 degrees colder than that of other ponds; showing, as might be expected, that a very shallow pond cools off more rapidly than a deep one. As an example of the very high temperature which water may attain in summer, it may be stated that, in a small and generally shallow reservoir at Wayland, on a sunny day at the end of June, 1889, the temperature of the water at the surface was 86 degrees, and two feet below the surface, 81 degrees.

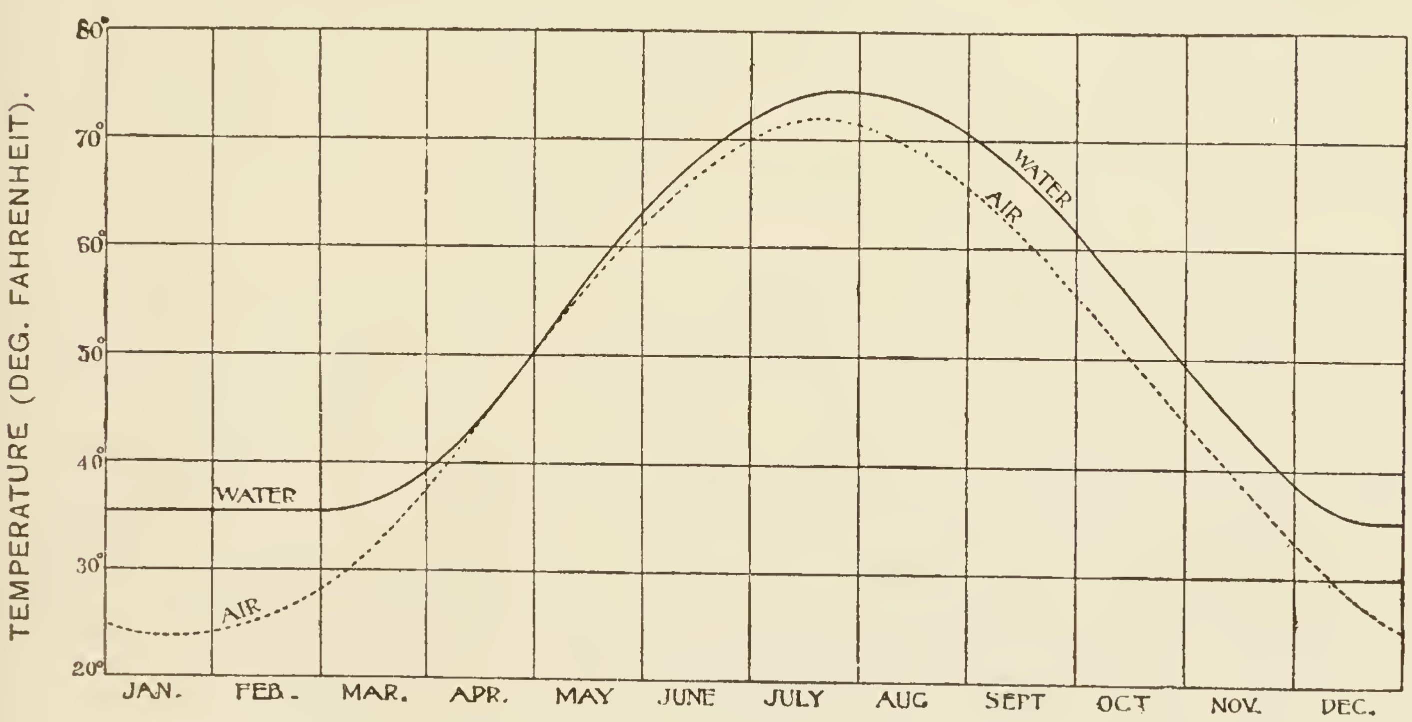
Notwithstanding these exceptional cases, the observations as a whole furnish an important addition to our knowledge, because it is now possible in most cases to deduce, from records kept regularly at several water works, the temperature of other waters when affected by abnormal growths of algæ, or by bad tastes and odors. In this we are not restricted to present and future cases; but, when the dates of past troubles are known, the temperatures associated with them may be determined.

The temperature of surface waters does not vary much from year to year; therefore, a mean curve deduced from the average of observations for a long period will represent approximately the fluctuations which occur each year. A curve of this kind and a table are given below, to each of which has been added the normal temperature of the air in Massachusetts, as obtained from the Bulletin of the New England Meteorological Society for 1888. This is shown on the diagram by a dotted line.

Table showing the normal temperature of water in ponds and reservoirs in Massachusetts, deduced from observations at three reservoirs for about ten years; also the normal temperature of the air.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Mean.
Ludlow Reservoir (average of ten years), ...	35.9	36.5	37.9	43.4	57.5	67.2	73.3	72.6	66.6	54.9	43.4	36.0	52.1
Brookline Reservoir (average of ten years), ...	36.8	36.4	37.6	44.8	57.1	66.7	72.8	72.8	67.5	56.5	45.6	37.3	52.6
Boston W. W. Reservoir, No. 3 (average of nine years), .	33.2	33.1	34.7	44.7	58.6	69.9	74.9	73.4	66.7	54.1	43.2	35.0	51.8
Mean (normal), ...	35.3	35.3	36.7	44.3	57.7	67.9	73.7	72.9	66.9	55.2	44.1	36.1	52.2
Normal temperature of air, .	24.1	25.8	32.2	43.9	56.3	66.0	71.4	68.6	60.8	50.1	39.0	28.5	47.2

A comparison of the two curves presents some interesting features. It will be noticed first that the water is always as warm as or warmer than the air. The reason for this in winter, when the difference is greatest, is obvious, as the temperature of the air at this time sinks



far below the freezing point, and the water is protected from the cold by a covering of ice. From the beginning of the spring until midsummer the differences between the temperatures of the air and water is small; but it is noticeable that the temperature of the water is always as high or higher than that of the air. After midsummer until winter the water is about five degrees warmer than the air.

The reason for this excess of temperature in summer is not as apparent as in winter, but may be explained by the daily range of

temperature of the air, which is warmer during portions of the day than the water. At these times the temperature of the water is increased by an amount which is greater than the loss during other portions of the day. The sun also tends to warm the water, irrespective of the temperature of the air.

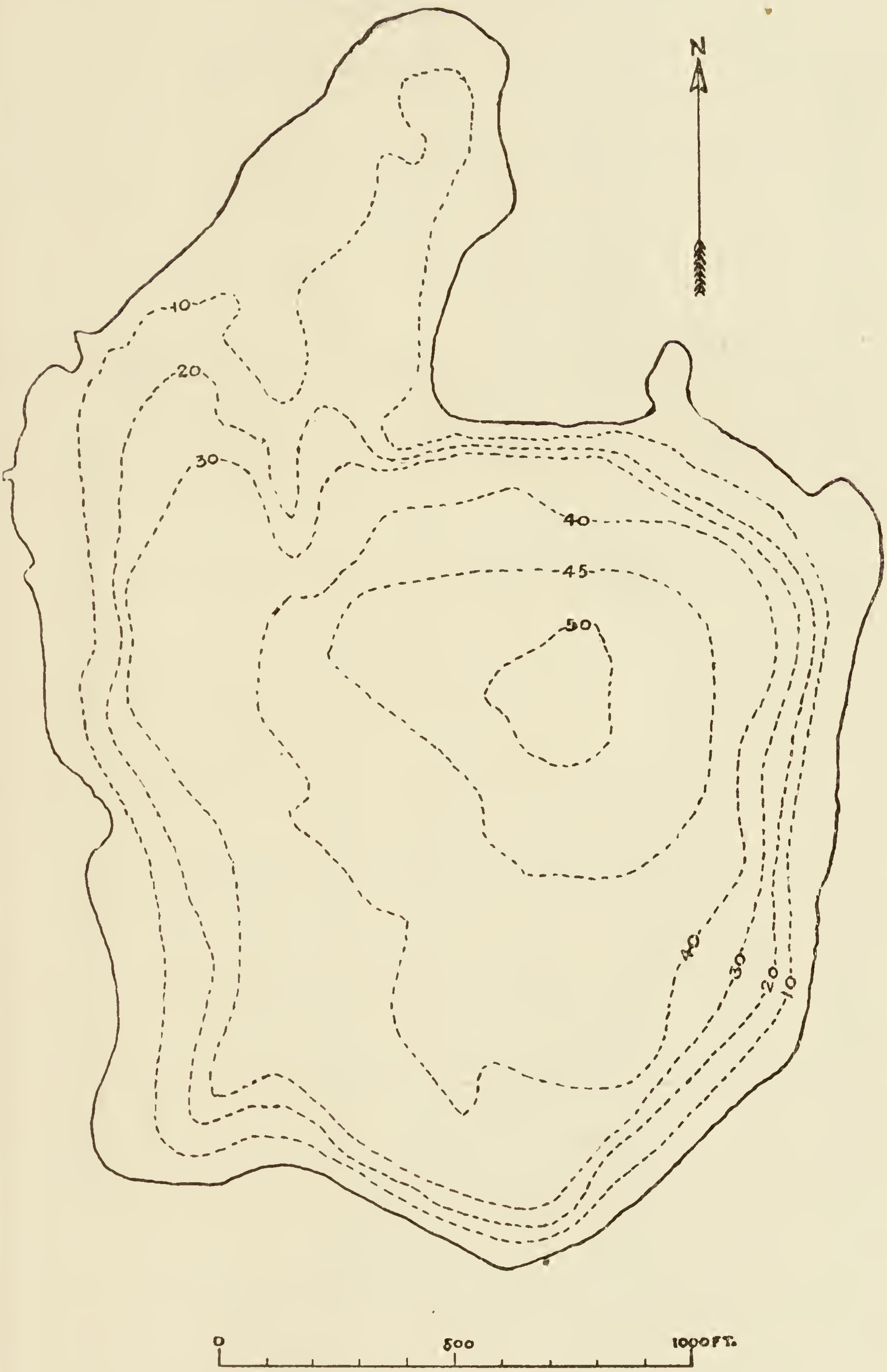
The departure from the normal temperature of the water during the two years beginning June 1, 1887, is indicated by the following table, in which the average monthly temperatures of Brookline and Ludlow reservoirs during these years are compared with the mean of ten years' observations at the same places. As a rule, the departures are small, and they correspond generally to the departures in temperature of the air already given.

	June.	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	Mean.
Average temperature for ten years,	66.9	73.0	72.7	67.0	55.7	44.5	36.6	36.3	36.4	37.7	44.1	57.3	52.3
June, 1887, to May, 1888,	66.9	75.0	73.8	65.6	55.5	42.6	37.0	37.0	37.0	38.4	42.4	55.2	52.2
Excess or deficiency,	0.0	+2.0	+1.1	−1.4	−0.2	−1.9	+0.4	+0.7	+0.6	+0.7	−1.7	−2.1	−0.1
June, 1888, to May, 1889,	67.7	71.4	72.8	66.7	52.2	45.4	36.4	36.6	36.6	38.9	47.2	61.8	52.8
Excess or deficiency,	+0.8	−1.6	+0.1	−0.3	−3.5	+0.9	−0.2	+0.3	+0.2	+1.2	+3.1	+4.5	+0.5

Allusion has already been made to differences in the temperature of different layers of water in deep ponds, whereby vertical currents are prevented or promoted. In view of the importance of this circulation or non-circulation upon the quality of the water, an extended series of physical, chemical and microscopical examinations of Jamaica Pond, Boston, have been made. Reference will be made here only to the temperature and its effect upon circulation, the discussion of other features being given subsequently.

Jamaica Pond has an area of 69 acres, a maximum depth of 57 feet, and an average depth of 27 feet. Its outline and contours of the bottom are shown by the following sketch: —

JAMAICA POND.



The temperatures were taken in the deepest portion of the pond at six depths; namely, at 1, 10, 20, 30, 40 and 50 feet below the surface. The observations were begun July 25, 1889, and have been continued for more than a year. The results are indicated upon the following diagram, on which is also shown, by a dotted line, the normal surface temperature of water in ponds and reservoirs.

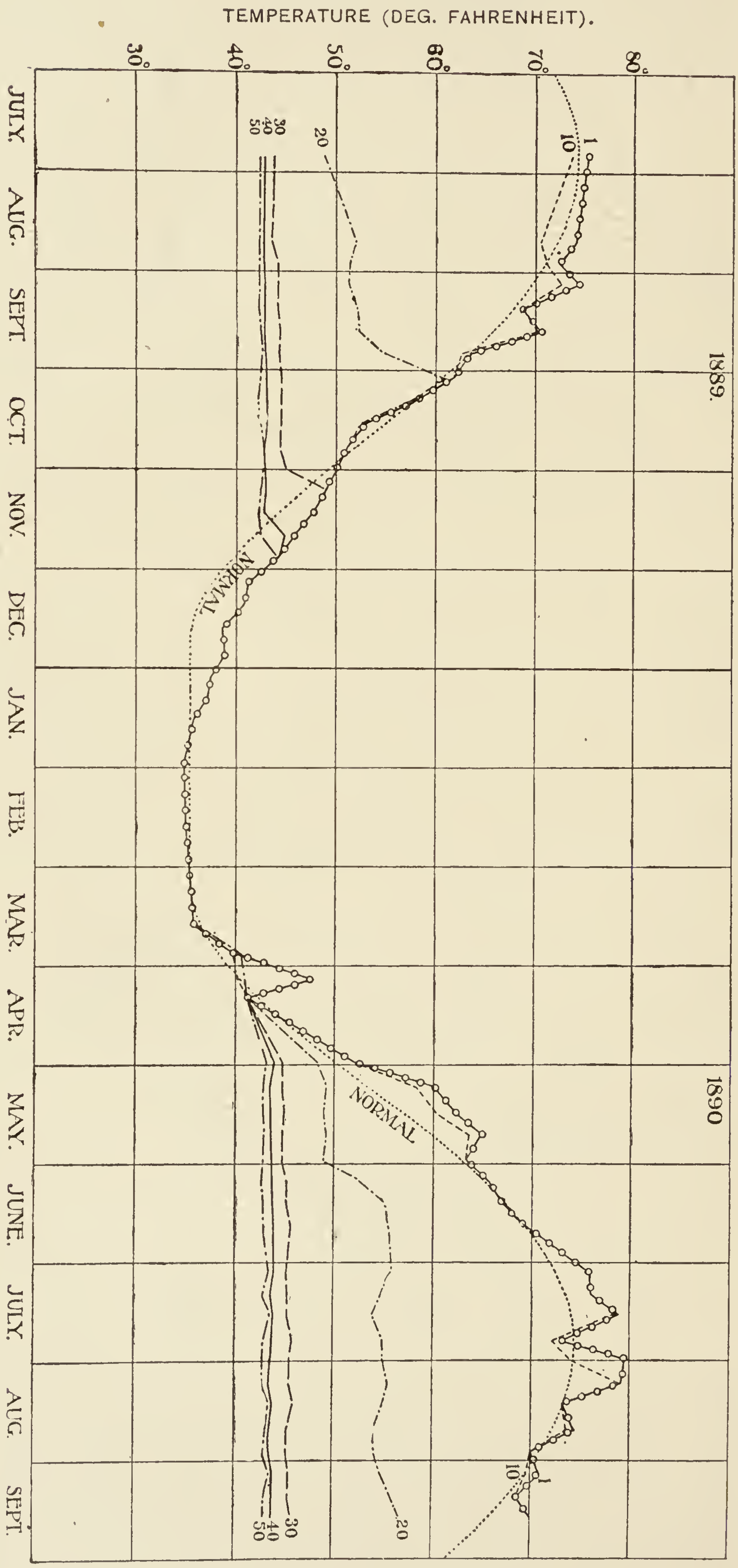


Diagram showing Temperatures in Jamaica Pond at six depths.

When the first observations were made, the temperature at a depth of one foot, which for convenience will be called the surface temperature, was 74 degrees, corresponding to that of other and shallower ponds, while the temperature at the bottom was 42 degrees; that is, 32 degrees colder than at the surface, and only 10 degrees above the freezing point. The temperature 10 feet below the surface corresponded quite nearly with that at the surface, while at all other depths the water was much colder, and consequently more dense. The temperatures at the three lower depths remained constant during the warm weather, showing that no appreciable amount of heat was transmitted from the upper layers, and that there was no interchange of water from the surface to the bottom. It is obvious that the wind produces currents at the surface of a pond which must be accompanied by return currents beneath the surface; and if the water is of uniform density at all depths, the circulation produced in this way will extend to the bottom; but if the lower layers are more dense the return currents will affect the water only to a limited depth. In the present case the low and generally constant temperature in summer at a depth of 20 feet makes it evident that they rarely extended to this depth. It will therefore be seen that the water at and below this depth was inaccessible to the air, and stagnant throughout the warmer months.

As the season advanced and the weather grew colder, the temperature of the surface water diminished, with a consequent increase in density, thereby establishing vertical currents down to the depth where a corresponding temperature was reached. This action would, in the absence of any other cause, have established circulation to continually increasing depths, reaching the bottom by the end of November. The mingling, however, at each of the depths, was hastened by the action of the wind, this effect being particularly noticeable at a depth of 20 feet, where the mingling occurred two weeks earlier than it otherwise would, and raised the temperature of the water at this depth 9 degrees higher than it was in the summer. November and December of this year were unusually warm, so that the whole of the water in the pond was not in circulation until nearly two weeks later than on an ordinary year. When circulation was fully established the temperature at all depths was 44 degrees.

The changes which occur after this in any deep pond are as follows. The cooling of the surface water promotes circulation

until 39 degrees — the temperature at which water acquires its maximum density — is reached, after which further cooling retards circulation. It does not, however, prevent it, as the winds at this season of the year can easily overcome the slight difference in density occasioned by a variation of a few degrees in this part of the scale. The temperature of the water usually remains nearly constant at 35 degrees during the winter, regardless of the character of the season, a cold winter furnishing its own protection by the formation of ice. In the spring, after the ice disappears, circulation is again established by the increase in temperature, and continues from this cause until the temperature of maximum density is reached, when it would cease, leaving the bottom water at 39 degrees, if it were not for the wind. This force usually continues to keep the water in circulation until a somewhat higher temperature is reached, and a period of warm, calm weather stops circulation by warming the surface water so that further interchange with the bottom layers is prevented. At Jamaica Pond the bottom water was left with a temperature of 42 degrees in 1889, and 43 degrees in 1890; and it remained stagnant, without exposure to the air, for seven months.

It will be observed, by reference to the diagram, that the temperature at a depth of 20 feet rose 6 degrees in the early part of June, 1890, while before and after this change it remained constant. It is evident that the wind at this time caused the water to circulate to this depth.

The observations at Jamaica Pond, where the average depth is unusually large, and there is no shallow flowage, afford another illustration of the fact that the surface temperatures in summer are affected but little, if at all, by the depth of a pond, unless it is very shallow.

All of the observations above given have been made at one pond, and it may be questioned to what extent they are generally applicable. At a larger pond or lake it is obvious that the wind would have a greater effect, and that circulation would take place to a greater depth in the warmer portion of the year. Other things being equal, the greater the depth the colder the bottom layers should be. With reservoirs of small depth, the wind will cause an interchange of water from the surface to the bottom, thereby producing a uniform temperature at all depths. The depth to which this occurs probably varies from 15 to 25 feet in the ponds and reservoirs of this State, depending both upon their size and the character of the season. Observations at Reservoir No. 3 of the Boston Water Works, which

has a maximum depth of 21 feet, have on some years shown a uniform temperature at all depths, while on other years the water at the bottom has been 8 or 10 degrees colder in the summer than at the surface. An observation at the Ludlow Reservoir, July 31, 1889, showed a uniform temperature to a depth of 20 feet.

The following table shows the results of observations of the temperature at different depths in six ponds, lakes or reservoirs, made in the summer of 1889.*

Temperature of Water at Different Depths.

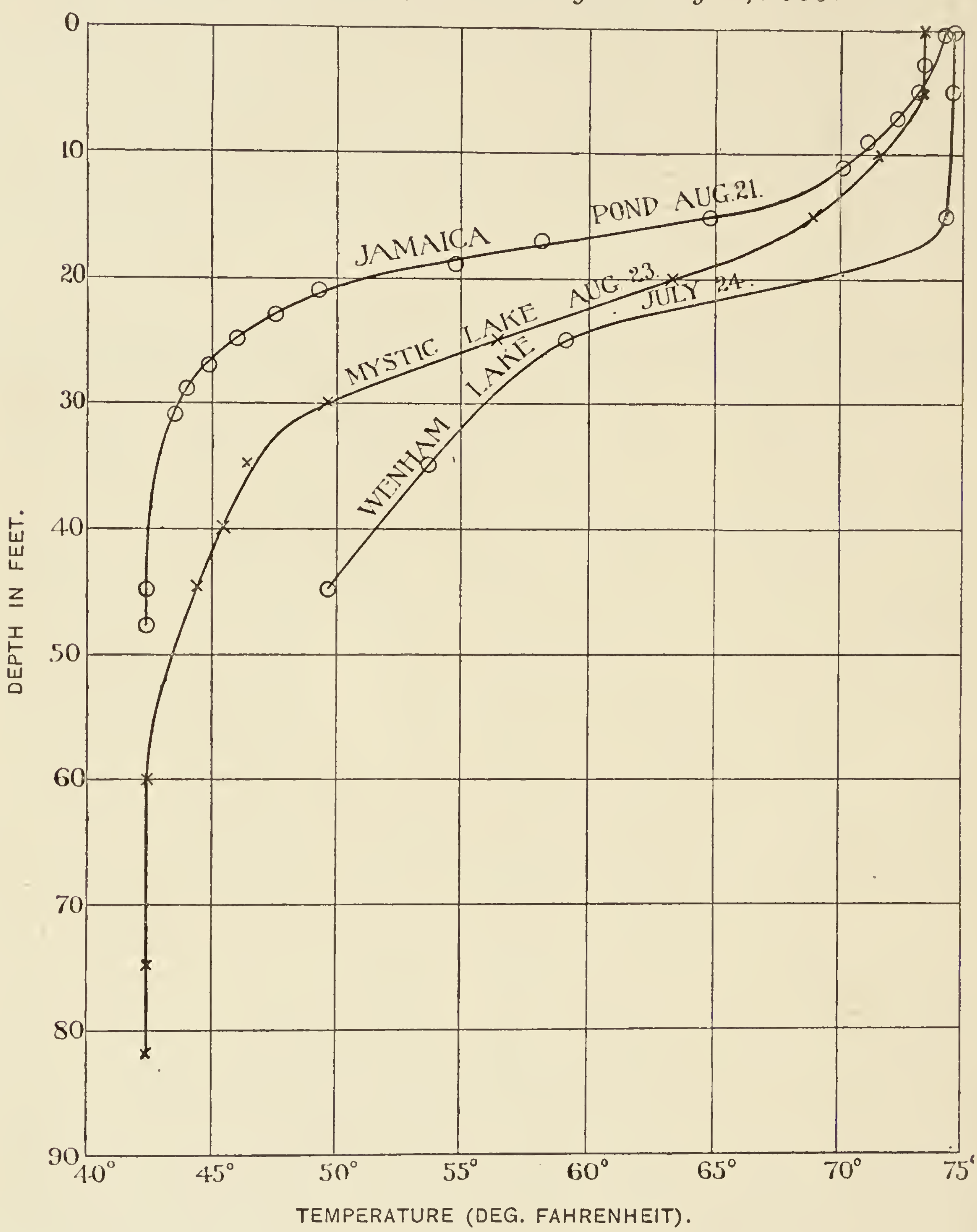
	Upper Mystic Lake, Medford.	Jamaica Pond, Boston.	Wenham Lake, Wenham.	Boston Water Works Reservoir No. 4, Ashland.	Waban Lake, Wellesley.	Boston Water Works Reservoir No. 3, Framingham.
Date, . .	Aug. 23, 1889.	Aug. 21, 1889.	July 24, 1889.	Aug. 23, 1889.	Aug. 27, 1889.	Aug. 26, 1889.
Area, . .	200 acres.	69 acres.	320 acres.	170 acres.	146 acres.	247 acres.
Max. depth, .	87 feet.	57 feet.	47 feet.	46 feet.	36 feet.	21 feet.
Average depth,	–	27 "	–	26 "	–	13 "
1 foot, . .	73.4 deg.	74.1 deg.	74.7 deg.	73.0 deg.	73.4 deg.	71.0 deg.
10 feet, . .	71.6 "	70.7 "	74.4 "	–	70.2 "	–
15 " . .	68.9 "	64.8 "	74.3 "	–	66.6 "	–
20 " . .	63.3 "	52.0 "	**69.0** "	–	57.6 "	68.0 "
23 " . .	**59.3** "	47.5 "	**61.5** "	65.0 "	**53.8** "	–
25 " . .	56.3 "	46.0 "	59.0 "	–	**51.5** "	–
30 " . .	49.6 "	43.7 "	**56.0** "	–	48.6 "	–
35 " . .	46.4 "	**43.0** "	53.6 "	–	47.8 "	–
40 " . .	45.5 "	**42.6** "	**51.4** "	–	–	–
45 " . .	44.4 "	42.4 "	49.6 "	53.0 "	–	–
60 " . .	42.8 "	–	–	–	–	–
82 " . .	42.8 "	–	–	–	–	–

It will be observed, by referring to the table, that the temperatures taken at 1 and 10 feet below the surface of the different bodies of water agree quite closely; while at greater depths there are large differences, the temperature generally increasing with the area of water surface. Reservoir No. 4 is to some extent an exception to the rule, as its temperatures below the surface are lower than at corresponding depths in the Upper Mystic and Wenham lakes, both of which are larger.

The following diagram contains temperature curves corresponding to observations at three of the places mentioned in the above table.

* The figures in bold-faced type are not actual observations, but have been interpolated to facilitate comparison.

Diagram showing Temperatures at Different Depths in Jamaica Pond and Mystic and Wenham Lakes, taken in July and August, 1889.



These curves agree with one another in their general form, although there are some marked differences between them. Such differences are to be expected, when it is considered that their form and position depend upon the circulation or non-circulation of the water by the wind, while the temperature is increasing in the spring.

Rivers. — The temperature of water in rivers varies a little more during the year than that of ponds and reservoirs, and, owing to the movement of the water, is uniform from the surface to the bottom. In the winters, when the rivers are covered with ice, the water flowing in

contact with it reaches the freezing point. In the spring this water warms up somewhat faster than the pond water, and in the autumn cools more rapidly. Exceptions to these general rules occur in the case of a large river like the Merrimack, where much of the water comes from north of the State, among the mountains, where the air is colder and the snow remains longer upon the ground in the spring.

The following table gives the temperature of the water of several rivers in the State, as compared with the standard for ponds and reservoirs previously given.

Temperature of Water in Rivers.

	Standard.	Merrimack River at Lawrence.	Taunton River at Taunton.	Charles River at Dedham.	Charles River at Waltham.	Charles River at Watertown.	Neponset River at Hyde Park.	Average of all Rivers except the Merrimack.
1887.								
June,	67.7	—1.3	-	-	+4.0	+4.3	+1.9	+3.4
July,	75.8	—0.1	+0.6	+3.3	+3.9	+4.0	+2.2	+2.8
August,	74.1	—3.2	—2.0	—0.7	+0.9	+2.8	—1.5	—0.1
September,	65.4	—3.1	—2.7	—2.9	—0.9	+3.1	—2.0	—1.1
October,	55.2	—2.9	—0.8	—1.1	—1.2	+1.5	—1.1	—0.5
November,	42.3	—2.6	—0.5	—0.9	—1.7	+2.9	—2.2	—0.5
December,	36.6	—2.9	—0.6	—0.5	—1.9	+1.4	—0.8	—0.5
1888.								
January,	35.8	—3.6	—3.7	-	-	-	—3.8	—3.7
February,	35.8	—3.4	—3.6	-	-	—3.4	—3.8	—3.6
March,	37.1	—4.2	—1.7	—0.1	-	—0.2	—4.0	—1.5
April,	42.0	—3.0	+4.3	+5.8	-	-	+0.3	+3.5
May,	55.6	—4.4	+2.4	+5.6	-	-	-	+4.0
June,	69.3	—0.9	+1.4	+3.2	-	-	-	+2.3
July,	71.8	0.0	0.0	+3.0	-	-	-	+1.5
August,	72.8	—1.1	—1.0	-	-	-	-	—1.0
September,	66.5	—2.8	—2.8	-	-	-	-	—2.8
October,	51.6	—4.9	—2.2	-	-	-	-	—2.2
November,	45.0	—3.7	0.0	-	-	-	-	0.0
December,	35.7	—2.0	—0.1	-	-	-	-	—0.1
1889.								
January,	35.7	—2.1	—0.1	-	-	-	-	—0.1
February,	36.2	—3.8	—3.9	-	-	-	-	—3.9
March,	38.4	—2.5	+0.6	-	-	-	-	+0.6
April,	47.3	+0.2	+2.7	-	-	-	-	+2.7
May,	63.1	—0.8	+0.7	-	-	-	-	+0.7

Temperature of Ground Waters.

The following table contains the observed temperatures of sixteen ground waters in various situations, arranged in the order of their temperatures in summer, the colder waters being placed on the left and the warmer ones on the right.

Average Monthly Temperatures of Ground Waters at Sixteen Places in Massachusetts.

	Newburyport Well.	Ware Well.	Westborough Tubular Wells.	Woburn Filter-gallery.	Hyde Park Tubular Wells.	Cohasset Tubular Wells.	Uxbridge Springs.	North Attleborough Well.	Dedham Well.	Wellesley Filter-gallery.	Waltham open Filter-basin.	Middleborough Well.	Milford Wells.	Watertown Filter-gallery.	Taunton open Filter-basin.	Framingham Filter-gallery.
January, ...	45.6	–	**49.6**	50.7	49.8	51.0	45.0	–	48.7	46.5	47.0	51.7	–	48.0	43.6	49.9
February, ...	45.3	–	50.4	50.7	49.0	49.0	–	–	48.0	45.0	46.0	**49.9**	–	44.2	42.8	49.0
March, ...	47.0	–	**49.9**	49.7	49.3	–	–	50.0	47.6	44.0	49.7	48.0	–	44.8	44.6	49.0
April, ...	47.3	–	49.5	49.1	50.0	50.0	–	50.0	48.0	46.0	51.3	**48.2**	–	**46.4**	48.2	49.5
May, ...	48.0	–	50.1	49.8	**50.0**	–	–	–	49.4	48.2	53.3	**50.1**	–	**48.5**	53.9	55.4
June, ...	48.2	–	51.2	50.5	48.5	52.0	–	–	52.0	51.2	54.1	52.5	–	50.9	58.2	61.9
July, ...	49.0	–	**51.2**	51.1	50.8	52.0	52.5	52.0	55.1	54.5	55.5	54.7	–	53.4	62.5	66.7
August, ...	49.0	50.2	51.0	51.9	52.4	52.7	53.6	53.8	56.3	56.8	56.9	58.7	59.6	60.9	62.4	65.5
September, ...	49.0	–	50.8	52.6	53.0	53.0	54.0	–	54.8	56.9	55.5	58.5	58.9	61.7	59.1	63.3
October, ...	48.9	–	50.2	53.0	53.0	–	53.5	–	54.1	55.2	53.4	57.2	–	56.8	54.7	57.2
November, ...	47.6	–	**49.4**	52.4	52.3	–	49.2	–	52.6	52.4	51.3	54.7	–	55.1	50.0	54.0
December, ...	46.4	–	49.0	51.5	51.6	52.0	49.0	–	50.6	48.5	49.7	52.7	54.5	52.0	45.5	51.2
Average, ...	47.6	–	50.2	51.1	50.8	–	–	–	51.4	50.4	52.0	53.1	–	51.9	52.1	56.0
Variation during year, . . .	3.7	–	2.2	3.9	4.5	–	–	–	8.7	12.9	10.9	10.7	–	17.5	19.7	17.7

NOTE.—The observations were begun in July, 1887, and have in some cases continued two or three years. The table in such cases contains the average of all observed temperatures for any given month. The figures in bold-faced type are interpolated.

The first thing noticeable in examining the table is the general uniformity of temperature of ground waters. In many instances the range of temperature during the year is but three or four degrees, while surface waters have an average range of 38 degrees. Some of the ground waters, given in the table, vary much more during the year than others; but none of them more than one-half as much as surface waters. At Waltham and Taunton the fluctuation is due wholly or in part to the exposure of the water to the air in open filter-basins. In Framingham the filter-gallery is separated from Farm Pond by only a few feet of sand, and the filtration of water from the pond influences the temperature in the gallery. Some of the other large fluctuations may be due to a similar cause, although filtration does not necessarily produce them. For example, the range of temperature during the year at Woburn is but 3.9 degrees, notwithstanding the fact that the supply is derived mainly from Horn Pond by filtration. In this case, however, there are indications that much of the water requires months for its passage from the pond to the filter-gallery.

The average annual temperature of ground water at eleven places where the observations were continued for a large part or the whole of a year is 51.5 degrees.

A few observations of the temperature of public ground water supplies not included in the table are as follows: —

Bridgewater.	
Well No. 1, June 19, 1888,	51.2 degrees.
Well No. 2, June 19, 1888,	52.2 degrees.
Well No. 1, July 24, 1888,	53.0 degrees.
Well No. 2, July 24, 1888,	53.6 degrees.
Revere.	
Well, June 3, 1887,	51.0 degrees.
Well, June 28, 1888,	49.9 degrees.
Well, July 9, 1888,	50.5 degrees.
Swampscott.	
Well, March 23, 1888,	46.8 degrees.
Well, April 24, 1888,	48.0 degrees.
Well, May 23, 1888,	49.5 degrees.

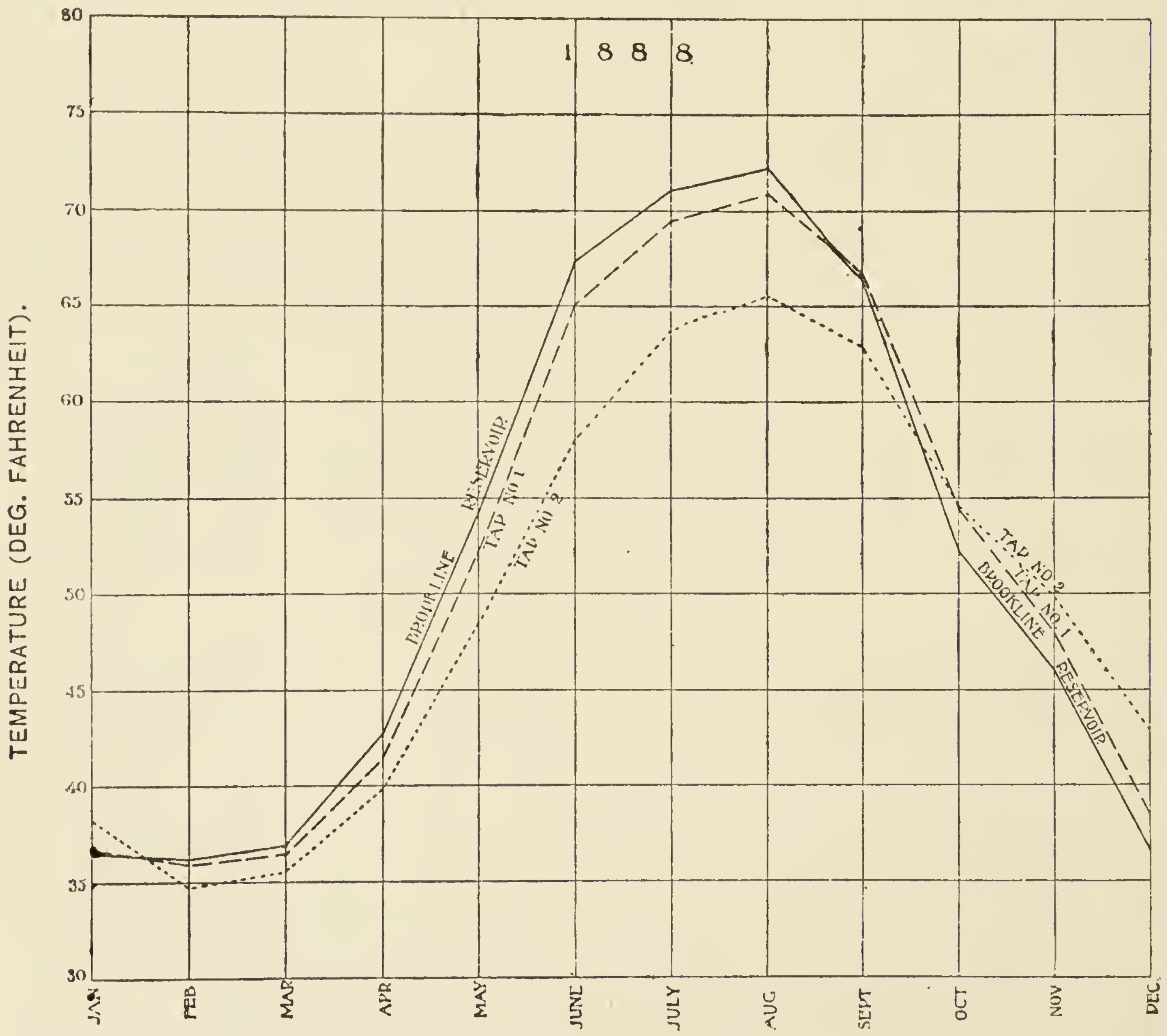
Temperature of Water as delivered to Consumers.

In the foregoing the temperatures of surface and ground waters at the sources of supply have been considered. It is obvious that the ground waters will have a great advantage over the surface

waters if both are delivered to the consumers at their initial temperatures, while this advantage will disappear if by their storage in reservoirs and passage through pipes they acquire an equal temperature.

Observations were made at Boston during the year 1888 to determine the comparative temperatures of a surface water in a distributing reservoir and as drawn from taps. One point of observation, which for convenience will be called Tap No. 1, was in the suburbs five miles from the Brookline Reservoir, but not far from a 24-inch main, so that it may be said to represent a place where there was active circulation of the water. The other point, Tap No. 2, was two miles further from the reservoir and near the end of the pipe system where there was but little circulation. The results are shown upon the following diagram.

Diagram showing Comparative Temperatures of Surface Water in a Reservoir and as Delivered to Consumers.



The diagram shows that there is but little difference between the temperature recorded at the reservoir and at Tap No. 1, the water

at the latter being about two degrees colder in the spring and summer and the same amount warmer in the autumn. The water at Tap No. 2 is obviously much more affected by the temperature of the ground through which the pipes pass, and in the summer is about eight degrees colder than the reservoir water.

The conclusion to be drawn from these observations is that the temperature of water at a tap will be influenced mainly by that at the source, except in those portions of the system where the circulation is not active.

No observations have been made to determine with what change of temperature ground water will pass from the source to the consumers if carried directly to them in pipes. It is probable, however, that it would not change very much.

A few observations have been made to indicate the effect of the storage of such water in iron tanks. At North Attleborough, on June 12, 1888, water drawn from the tank 20 hours after pumping had ceased was 2 degrees warmer than the water in the well. At Swampscott water drawn from the tank was 3.8 degrees colder than that in the well on March 23, 1888; 2 4 degrees colder April 24, and 2.6 degrees warmer May 23. These observations do not indicate any very great change of temperature from storage in tanks.

When ground water is stored in an open distributing reservoir the surface becomes warmed in summer, as shown by the following observations: —

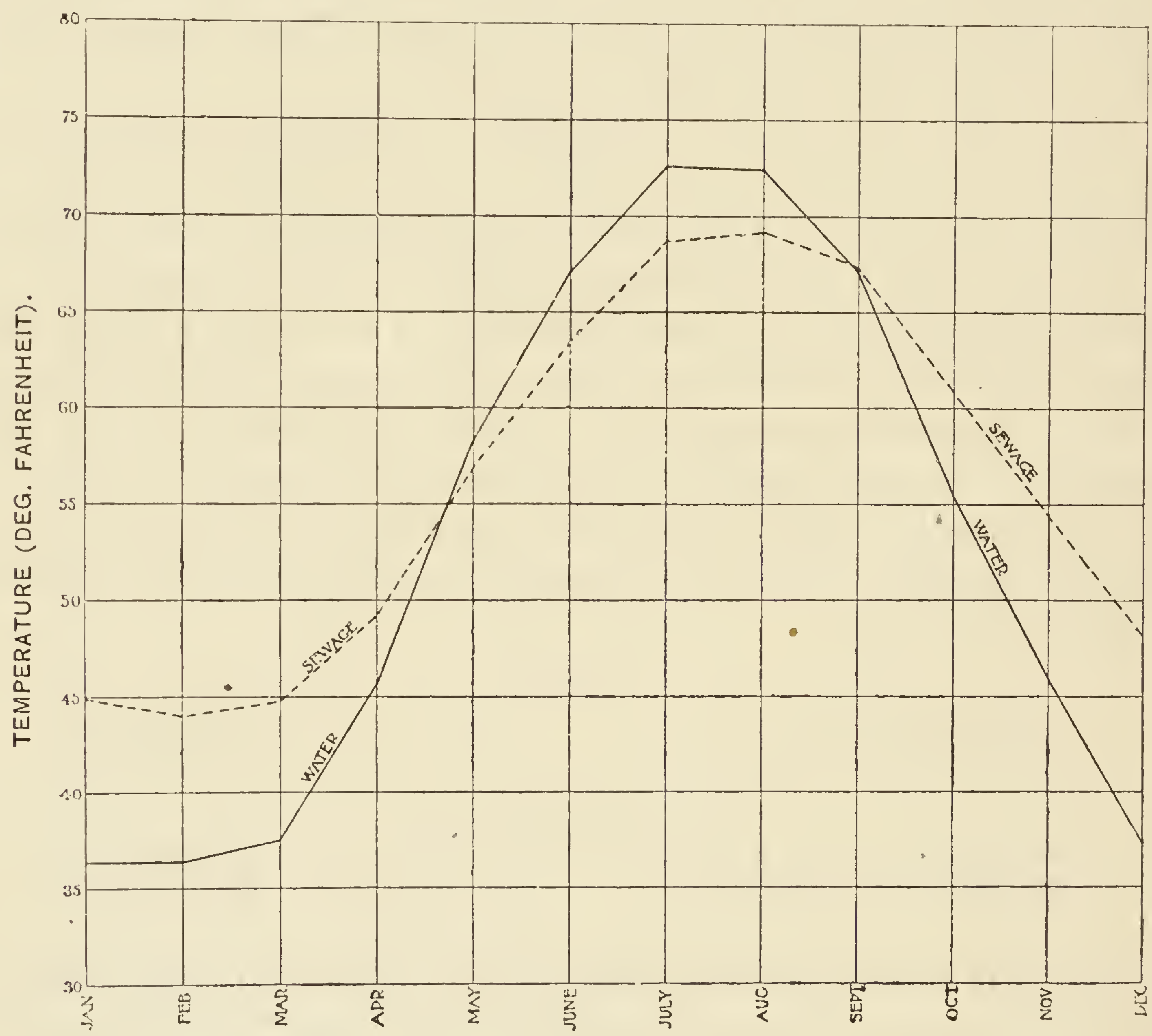
Revere.	
Well, July 9, 1888,	50.5 degrees.
Reservoir, July 9, 1888,	70.2 degrees.
Woburn.	
Filter-gallery, June 5, 1888,	50.0 degrees.
Reservoir, June 5, 1888,	66.0 degrees.

It should not be inferred that the water delivered to the consumer will be as warm as that at the surface of the reservoir; since much of the water in cases of this kind is pumped directly to the consumer, and that portion which enters the reservoir at the bottom may on account of its greater density remain there until drawn without acquiring the surface temperature.

The foregoing observations, though not conclusive, indicate that the temperature of water as delivered to consumers depends mainly upon that at the source. If this is the case, ground waters have the advantage that, as drawn from the tap, they are much more palatable

in the summer, and less likely to freeze in the pipes in winter. They also have some advantage where a city or town has to dispose of its sewage by filtration through land, in that the sewage is warmer in winter. The relation of the temperature of a surface water supply to that of sewage is given in the following diagram, in which the temperature of the water of the Brookline Reservoir of the Boston Water Works is compared with that of sewage entering the reservoir of the Boston Main Drainage Works. The diagram is based upon five years' observations.

Diagram showing Comparative Temperatures of Water and Sewage.



The diagram shows clearly that the temperature of sewage is governed to a considerable extent by the temperature of the water supply. The sewage is, however, about eight degrees warmer in winter and three degrees colder in summer than this water.

A CLASSIFICATION

OF THE

DRINKING WATERS

OF THE STATE.

A CLASSIFICATION

OF THE

DRINKING WATERS OF THE STATE.

From the stand-point of the public health, the natural classification of waters is into those which have at no time been contaminated by the waste products of human life, and those which have been thus contaminated. Waters of the first class we have called normal; in the latter class, we attempt to express the amount of polluting matter of the nature of sewage which the water has received, by giving its variation from the normal chlorine contents of the region.

The subject has already been discussed in the chapter on the interpretation of analyses. It was there shown that we have in the chlorine contents of the water the evidence that we need to determine whether or not a body of water has received house drainage, either directly, as when the sewage of a town flows into a stream, or indirectly, as when the drainage from houses or cess-pools reaches the water courses after filtration through the ground.

In the accompanying map of normal chlorine of Massachusetts, the points of like normal chlorine have been connected by lines which we will call *isochlors*. It will be noticed that these isochlors, which represent a difference of 0.05 part of chlorine in 100,000 of water, are, in the eastern part of the State, close together, approximately parallel, and conform in a general way to the coast line. As we recede from the coast westward, the isochlors are wider apart and their parallelism is less marked.

In the following tabulations of the waters of the State according to their chlorine contents, this map has been used as the basis; that is to say, when the average chlorine contents of a water agree with the isochlors on the map, the water is considered normal; when the amount of chlorine is in excess of the normal, the amount of this excess expresses the extent to which the water is believed to have been polluted. This use of the map of normal chlorine we find justified in most of the cases where we have an accurate knowledge of the drainage area; in other words, we find the excess of chlorine

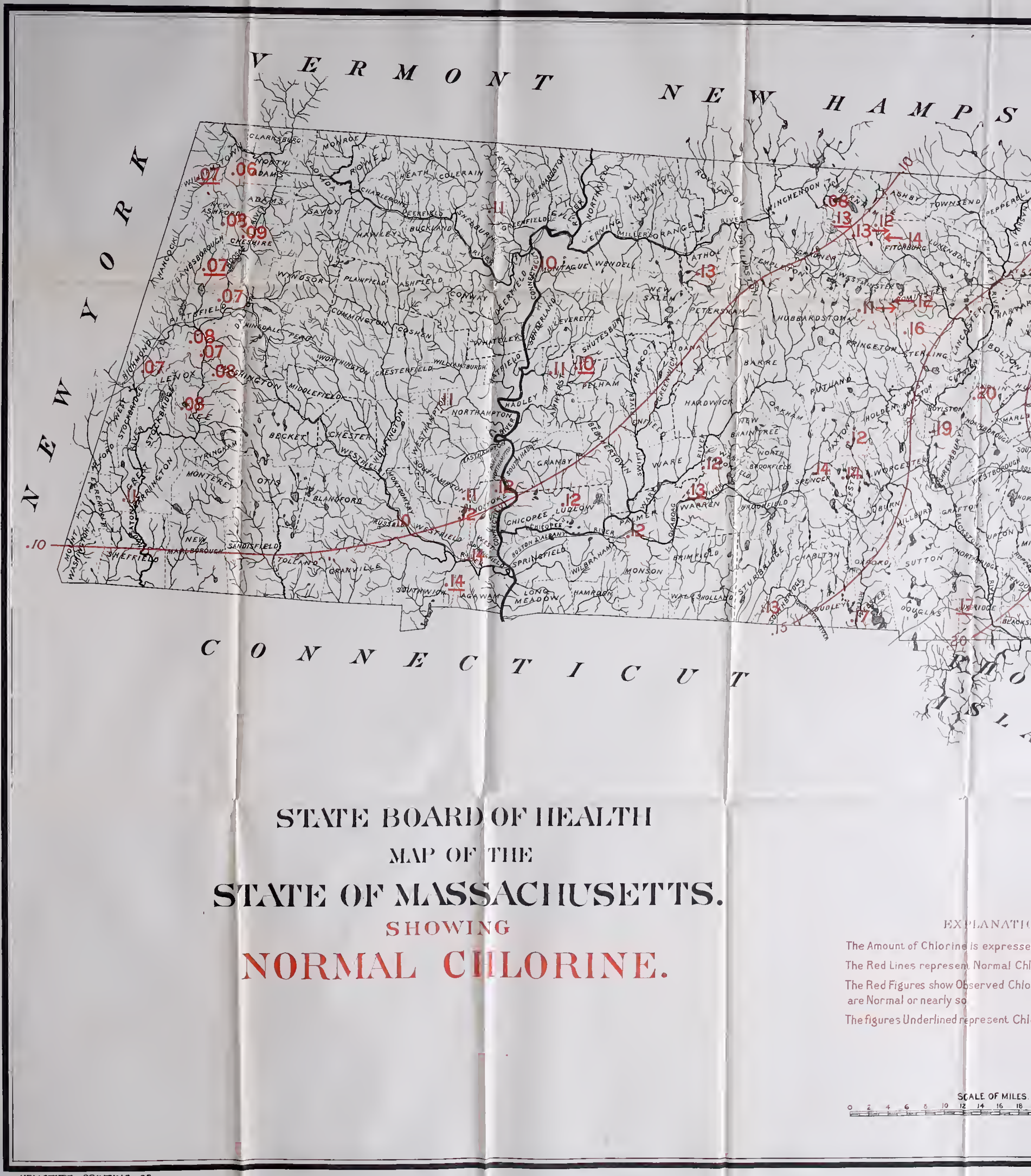
in the water to be in proportion to the population on the drainage area.

There are no data in this country sufficiently complete from which we can determine the amount of chlorine contributed to sewage by each inhabitant per day. Calculations based on the volume of sewage per inhabitant in London, and determinations of the amount of chlorine in the sewage and in the water supply, indicate that the amount of chlorine per person per day is 0.045 pound. The average daily flow of the Sudbury River per square mile of drainage area for the past eleven years is 8,500,000 pounds of water per day. Assuming the data derived from London sewage to be generally applicable, we find that it requires nineteen persons per square mile to increase the chlorine in the water flowing from a drainage area of the size of the Sudbury River .01 of a part per 100,000. Another way of arriving at the population required to produce this result, is to divide the population per square mile of watersheds in Massachusetts by the corresponding excess of chlorine in the water. In this way we find, from an average of observations of fifteen streams and reservoirs, that it requires twenty-one persons per square mile to increase the chlorine .01. Observations of nine other streams, where a portion of the chlorine is probably due to manufacturing wastes, give but thirteen inhabitants per .01 increase of chlorine. There are a few streams where the amount of chlorine furnished by manufacturing is still greater, so that each .01 of chlorine corresponds to a still smaller population, the minimum number found being 2.8 persons per square mile.

All the foregoing results are based upon averages for a year or more. In the summer, when the flow is small, the population corresponding to .01 excess of chlorine is much smaller, the average of several observations upon streams being seven persons per square mile.

The average results obtained from analyses of ponds should be somewhat larger than those of streams; but the individual results vary so much that it is unnecessary to consider a refinement of this kind. We may say, in a general way, that four families or 20 persons per square mile will add, on an average, .01 of a part per 100,000 of chlorine to the water flowing from this area, and that a much smaller population will have the same effect during seasons of low flow.

While we feel confident in the general correctness of the application of the map for the determination of the degree to which the



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MPSHIRE
ATLANTIC
OCEAN
CAPE COD
BAY
BUZZARDS BAY
VINEYARD SOUND
RHODE
ISLAND
EXPLANATION.
nt of Chlorine is expressed in parts per 100,000.
nes represent Normal Chlorine.
gures show Observed Chlorines which
al or nearly so.
s Underlined represent Chlorines of Ground Waters.
SCALE OF MILES.
6 8 10 12 14 16 18 20 22 24 26 28 30

waters have been polluted, it is important that the limitations of its use be clearly understood. Some of these limitations are: —

1. Those waters have been called normal, and have been used in establishing the isochlors, which drain areas believed to be nearly or quite free from population. Until a careful survey of the State be made, with the express object in view of determining the relation of population to the surface and ground waters, we cannot be sure in all cases that we actually have normal water. The normals as now given represent the present state of our knowledge of this relation.

2. Since the source of the chlorine in the normal waters of the State is mainly the salt of the sea water, it is obvious that the direction and force of the wind and the amount and distribution of the rainfall are the important factors governing the amount of chlorine in these waters. The chlorine contents of the waters through which the isochlors are drawn represent, in most cases, the average of monthly determinations from June, 1887, to May, 1889. It may be that another period of like duration, with different meteorological conditions, would give isochlors which would vary in position somewhat from those on the map.

3. It has been already clearly pointed out (page 543) that the single determinations of the chlorine from which the normal averages are made vary greatly, often 50 or 100 per cent., and in some cases even more. It is clear, therefore, that a single determination of chlorine may be misleading, when compared with the average normal chlorine.

4. In the eastern part of the State, where the isochlors are near together, it is evident that slight variations from the normal have less significance than in the western part of the State, where the same normal covers a larger area.

5. In any case too much importance must not be attached to slight variations from the normal, as shown on the map, say to the extent of 0.05 part in 100,000. The necessities involved in drawing the isochlors with our present knowledge will often cause a variation, plus or minus, of this amount, in waters believed to be normal. This is particularly the case near the sea, where a general parallelism with the coast has been observed in drawing the isochlors. These irregularities will, it is believed, largely disappear when further surveys and analyses give us more complete knowledge of the waters of the State. Our examinations have hitherto been mainly confined

to public water supplies, and the waters of some of the larger rivers. To make the map of normal chlorine complete and accurate, the smaller streams in uninhabited regions should be examined regularly for some years.

In a few cases which will call for detailed mention hereafter, we have a considerable excess of chlorine above the normal, which we are unable to account for by the population on the drainage area. These cases are to be made the subject of future examination. It may be discovered that certain waters contain chlorine of other origin than sewage, or from the sea; as, for instance, from salt contained in certain geological formations, or from factories in which salt or other chlorides are largely used.

6. It must be kept in mind that the excess of chlorine in a water above the normal does not necessarily imply *present* pollution. The organic matter and ammonia which sewage has brought into a water may have long since disappeared by oxidation or absorption by plants, but the salt, which is not subject to change, remains. It is thus possible to have a pure water, organically speaking, which shows by its chlorine contents that it was once badly polluted by sewage. This is particularly true of ground waters, since the oxidizing power of porous earth on organic matter is very great.

In this classification of the drinking waters of the State on the basis of their chlorine contents, the surface waters and ground waters are grouped separately, owing to their essential and radical difference in character and composition. In all cases the analyses represent the waters at their sources, and not as they are supplied to the consumer.

Surface Waters.

Upon tabulating the ninety surface waters of the State that are used for public drinking supplies, we find that twenty-six of them have no excess of chlorine above the normal, which indicates that they are unpolluted by sewage. We find twenty-five other sources having so small an excess of chlorine, it being within the limits of error of our standard, that we cannot say that they are in the least polluted by household wastes. Some of these are in districts known to be free from such pollution. We have, then, the satisfaction of knowing that as many as one-third and probably more than one-half of the public drinking supplies of the State, obtained from surface waters, are unpolluted by sewage.

Most of the remainder — thirty-three in number — have excess of

chlorine from 0.04 to 0.25 parts per 100,000, which indicates that they contain from one to five per cent. of water containing as much salt as ordinary sewage.

There are seven sources which show a greater excess of chlorine.

These four groups are arranged in the following tables : —

Table No. 1.

Surface waters, in which the chlorine is normal, arranged in the order of albuminoid ammonias.

(Parts per 100,000.)

City or Town.	Source.	Color.	Residue on Evaporation.		Ammonia.			Nitrogen as		Total Nitrogen.	Excess of Chlorine.
			Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Suspended.	Nitrates.	Nitrites.		
Lenox,	Storage Reservoir,	0.00	5.62	0.35	.0001	.0028	–	.0044	.0001	.0092	–
North Adams,	Notch Brook,	0.04	7.38	0.50	.0003	.0042	–	.0054	.0000	.0125	–
Adams,	Bassett Brook Reservoir,	0.07	4.12	0.67	.0011	.0075	–	.0128	–	.0260	.00
Pittsfield,	Sackett Reservoir,	0.11	6.59	1.05	.0006	.0077	–	.0112	.0000	.0243	.00
Dalton,	Egypt Brook,	0.29	2.73	0.92	.0002	.0080	–	.0196	.0001	.0330	–
Lee,	Storage Reservoir,	0.19	4.26	0.96	.0003	.0087	–	.0075	.0000	.0220	–
Palmer,	Storage Reservoir,	0.19	3.90	0.73	.0004	.0087	–	.0054	.0000	.0200	.00
Leominster,	Morse Reservoir,	0.24	2.30	0.67	.0006	.0093	–	.0032	–	.0189	–
Peabody,	Spring Pond,	0.00	3.91	0.87	.0001	.0111	–	.0000	–	.0183	.00
Plymouth,	Great South Pond,	0.00	2.60	0.53	.0004	.0117	–	.0015	.0000	.0210	.00
Concord,	Sandy Pond,	0.03	2.66	0.76	.0001	.0129	–	.0041	.0001	.0254	.00
Pittsfield,	Ashley Reservoir,	0.18	5.87	1.04	.0005	.0140	–	.0090	.0001	.0325	–
Plymouth,	Little South Pond,	0.00	2.64	0.57	.0003	.0144	–	.0011	.0000	.0250	.00
Westfield,	Storage Reservoir,	0.54	3.04	1.05	.0003	.0147	–	.0044	.0001	.0289	.00
Worcester,	Tatnuck Brook Storage Reservoir,	0.19	2.43	0.86	.0009	.0155	.0042	.0038	.0001	.0301	–
Nantucket,	Wannacomet Pond,	0.07	6.35	1.09	.0002	.0163	–	.0034	.0002	.0305	.00
Haverhill,	Crystal Lake,	0.13	3.22	0.98	.0009	.0166	–	.0030	–	.0310	.00
Peabody,	Brown's Pond,	0.17	3.00	1.05	.0001	.0169	–	.0013	–	.0291	.00
Southbridge,	Storage Reservoir,	0.25	3.67	1.01	.0014	.0181	.0045	.0045	.0001	.0354	.00
Pittsfield,	Ashley Lake,	0.34	3.37	1.36	.0026	.0191	–	.0040	.0001	.0376	.00
Lynn,	Breed's Pond,	0.48	3.84	1.42	.0018	.0214	.0049	.0042	.0001	.0409	.00
Gloucester,	Dikes Brook Storage Reservoir,	0.52	4.67	1.73	.0069	.0229	.0074	.0044	.0002	.0478	–
New Bedford,	Conduit,	1.36	5.19	2.08	.0015	.0248	.0018	.0150	.0001	.0570	.00
Lynn,	Birch Pond,	0.36	3.92	1.59	.0019	.0272	.0072	.0065	.0001	.0528	.00
Wayland,	Storage Reservoir,	0.83	4.44	1.59	.0020	.0298	.0040	.0108	.0001	.0614	–
Leominster,	Haynes Reservoir,	0.39	3.17	1.63	.0023	.0409	.0133	.0067	.0001	.0758	–
Average,		0.27	4.03	1.04	.0011	.0156	.0059	.0060	.0001	.0326	–

TABLE NO. 2.

Surface waters, in which the excess of chlorine is from .01 to .03 parts per 100,000, inclusive, arranged in the order of albuminoid ammonias.

(Parts per 100,000.)

City or Town.	Source.	Color.	Residue on Evaporation.		Ammonia.			Nitrogen as		Total Nitrogen.	Excess of Chlorine.
						Albuminoid.					
			Total.	Loss on Ignition.	Free.	Total.	Suspended.	Nitrates.	Nitrites.		
Greenfield, .	Glen Brook Storage Reservoir, ...	0.03	5.09	0.48	.0010	.0046	–	.0090	.0001	.0175	.03
Gt. Barrington,	Storage Reservoir, . .	0.06	4.70	0.67	.0003	.0053	–	.0100	.0000	.0189	.01
Clinton, . .	"The Basin," . . .	0.25	4.53	0.80	.0005	.0078	–	.0116	.0001	.0249	.02
Montague, .	Lake Pleasant, . . .	0.01	2.59	0.66	.0021	.0081	.0013	.0064	.0000	.0214	.02
South Hadley,	Storage Reservoir, . .	0.39	3.61	0.76	.0010	.0089	–	.0133	.0001	.0288	.02
Amherst, . .	Amethyst Brook Storage Reservoir, . . .	0.59	3.69	1.15	.0003	.0109	–	.0084	.0000	.0265	.02
Adams, . .	Dry Brook Storage Reservoir, ...	0.24	7.50	1.29	.0012	.0111	–	.0068	–	.0260	.01
Northampton, .	Storage Reservoir, . .	0.30	4.37	0.95	.0003	.0113	–	.0058	.0000	.0246	.03
Webster, . .	LakeChaubunagungamaug,	0.06	2.18	0.66	.0002	.0129	–	.0043	.0000	.0256	.01
W. Springfield,	Storage Reservoir, . .	0.31	4.11	0.89	.0009	.0133	–	.0057	.0001	.0283	.03
Spencer, . .	Shaw Pond, . . .	0.03	2.69	0.85	.0007	.0136	–	.0059	.0001	.0289	.01
Fitchburg, .	Overlook Reservoir, .	0.10	2.41	0.49	.0012	.0151	.0034	.0041	.0001	.0299	.02
Hudson, . .	Gates Pond, . . .	0.05	3.01	0.68	.0014	.0155	.0029	.0056	.0001	.0323	.02
New Bedford, .	Little Quittacas Pond, .	0.19	2.96	1.15	.0003	.0160	–	.0035	.0000	.0300	.02
Fall River, .	Watuppa Lake, . . .	0.19	3.26	0.98	.0005	.0162	.0020	.0055	.0001	.0326	.02
Worcester, .	Lynde Brook Storage Reservoir, ...	0.25	2.98	0.91	.0040	.0162	.0021	.0062	.0001	.0361	.01
Athol, . .	Small Phillipston Reservoir, ...	1.08	3.98	1.59	.0009	.0176	–	.0066	.0000	.0362	.03
Holyoke, . .	Whiting Street Brook, .	0.29	7.22	1.27	.0013	.0179	.0033	.0089	.0001	.0394	.01
Fitchburg, .	Falulah Reservoir, . .	0.28	2.74	0.82	.0008	.0180	.0047	.0042	.0001	.0346	.01
Holyoke, . .	Wright and Ashley Ponds,	0.06	5.18	0.82	.0023	.0184	.0043	.0043	.0001	.0366	.02
Danvers, . .	Middleton Pond, . .	0.62	4.37	1.48	.0008	.0207	.0035	.0049	.0001	.0396	.01
Fitchburg, .	Scott Reservoir, . .	0.16	2.52	0.92	.0006	.0226	.0073	.0034	.0001	.0411	.03
Northborough,	Storage Reservoir, . .	0.85	4.43	1.56	.0013	.0230	–	.0081	.0001	.0470	.02
Tewksbury, .	State Almshouse Brook, .	0.91	4.87	1.69	.0022	.0256	.0043	.0063	.0001	.0502	.01
Boston, . .	Reservoir 4, . . .	0.73	3.75	1.52	.0006	.0260	.0042	.0056	.0001	.0488	.03
Springfield, .	Ludlow Reservoir, . .	0.15	3.45	1.52	.0019	.0381	.0154	.0039	.0002	.0681	.01
Brockton, .	Salisbury Brook Reservoir,	0.75	4.44	1.93	.0028	.0411	.0163	.0058	.0001	.0756	.01
Average, .	. . . .	0.33	3.95	1.06	.0012	.0169	.0054	.0064	.0001	.0352	.02

TABLE NO. 3.

Surface waters, in which the excess of chlorine is from 0.04 parts per 100,000 to 0.25 parts, arranged in order of excess of chlorine.

(Parts per 100,000.)

City or Town.	Source.	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Suspended.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Total Nitrogen.	Excess of Chlorine.
Haverhill,	Kenoza Lake,	0.02	3.81	0.74	.0006	.0142	.0014	.0045	.0001	.0285	.04
Norwood,	Buckmaster Pond,	0.13	2.74	1.01	.0055	.0220	.0026	.0061	.0002	.0469	.04
Westborough,	Storage Reservoir,	0.45	3.12	1.25	.0026	.0244	–	.0079	.0001	.0501	.04
Hingham,	Accord Pond,	0.24	3.25	1.00	.0003	.0144	.0017	.0043	.0001	.0283	.05
Abington,	Big Sandy Pond,	0.15	3.36	0.88	.0008	.0160	–	.0063	.0001	.0334	.05
Chicopee Falls,	Chicopee River,	0.43	4.17	1.14	.0015	.0163	.0035	.0098	.0002	.0380	.05
Springfield,	Van Horn Reservoir,	0.14	3.40	1.11	.0098	.0268	.0052	.0201	.0002	.0723	.05
Chicopee,	Dingle Brook Reservoir,	0.20	3.88	0.81	.0010	.0135	.0054	.0138	.0002	.0370	.06
Lowell,	Merrimack River,	0.31	5.11	1.06	.0019	.0149	.0026	.0092	.0002	.0354	.06
Sherborn,	Waushakum Pond,	0.23	4.16	1.13	.0009	.0195	–	.0060	.0001	.0388	.06
Malden,	Spot Pond,	0.24	4.30	1.24	.0007	.0216	.0029	.0044	.0001	.0405	.06
Lawrence,	Distributing Reservoir,	0.28	3.97	0.99	.0025	.0142	.0014	.0151	.0003	.0407	.07
Lawrence,	Merrimack River,	0.34	4.85	1.11	.0022	.0178	.0034	.0096	.0003	.0409	.07
Weymouth,	Great Pond,	0.91	4.16	1.80	.0010	.0224	–	.0037	.0000	.0413	.07
Lowell,	Distributing Reservoir,	0.28	4.15	1.09	.0028	.0139	.0025	.0177	.0002	.0430	.08
Salem,	Wenham Lake,	0.05	4.62	0.80	.0018	.0143	.0028	.0047	.0001	.0297	.09
Haverhill,	Lake Pentucket,	0.02	3.42	0.78	.0007	.0164	–	.0040	.0001	.0316	.09
Cambridge,	Stony Brook Storage Reservoir,	0.73	5.54	1.74	.0033	.0286	.0048	.0151	.0002	.0649	.09
Randolph,	Great Pond,	0.76	3.96	1.27	.0008	.0253	.0026	.0043	.0001	.0465	.10
Hingham,	Fulling Mill Pond,	0.36	5.33	1.30	.0028	.0282	.0131	.0068	.0002	.0555	.10
Taunton,	Taunton River,	1.45	5.74	2.18	.0019	.0284	.0035	.0084	.0001	.0566	.10
Boston,	Reservoir 2,	1.01	4.79	1.88	.0008	.0296	.0053	.0089	.0002	.0583	.10
Gardner,	Crystal Lake,	0.02	2.62	0.62	.0013	.0111	–	.0050	.0001	.0244	.11
Quincy,	Storage Reservoir,	0.41	*3.68	1.06	.0027	.0215	.0065	.0096	.0003	.0474	.11
Easthampton,	Storage Reservoir,	0.27	4.53	1.02	.0021	.0170	.0034	.0140	.0003	.0439	.13
Springfield,	Lombard Reservoir,	0.09	3.45	0.68	.0015	.0175	–	.0117	.0003	.0419	.13
Winchester,	Storage Reservoir,	0.14	5.04	1.21	.0033	.0241	.0058	.0104	.0003	.0529	.13
Wakefield,	Crystal Lake,	0.14	3.73	0.92	.0008	.0165	.0017	.0079	.0001	.0357	.14
Boston,	Chestnut Hill Reservoir,	0.38	5.08	1.43	.0019	.0222	.0028	.0200	.0002	.0582	.19
Boston,	Reservoir 3,	0.87	5.25	1.85	.0049	.0285	.0044	.0219	.0003	.0729	.19
Boston,	Lake Cochituate,	0.25	5.09	1.22	.0026	.0207	.0039	.0148	.0003	.0512	.20
Boston,	Tap in City,	0.38	4.98	1.47	.0008	.0207	.0022	.0206	.0002	.0554	.20
Marlborough,	Lake Williams,	0.06	4.02	0.70	.0006	.0196	.0043	.0053	.0001	.0380	.25
Average,		0.36	4.22	1.17	.0021	.0201	.0038	.0101	.0002	.0445	.10

* Filtered.

TABLE No. 4.

Surface waters, in which the excess of chlorine is 0.30 parts or mcre, arranged in the order of excess of chlorine.

(Parts per 100,000.)

City or Town.	Source.	Color.	Residue on Evaporation.		Ammonia.			Nitrogen as		Total Nitrogen.	Excess of Chlorine.
			Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Suspended.	Nitrates.	Nitrites.		
Haverhill, . .	Lake Saltonstall, .	0.05	4.51	0.77	.0015	.0145	–	.0050	.0003	.0302	.30
Whitman, . .	Hobarts Pond, .	1.00	6.58	2.26	.0061	.0435	.0085	.0122	.0003	.0888	.31
Boston, . .	Jamaica Pond, .	0.03	6.80	1.04	.0157	.0398	.0299	.0160	.0004	.0941	.33
Arlington, .	Storage Reservoir,	0.73	7.96	2.69	.0024	.0475	.0165	.0246	.0002	.1047	.36
Natick, . .	Dug Pond, . .	0.15	5.29	0.98	.0050	.0218	.0039	.0238	.0004	.0649	.44
Cambridge, .	Fresh Pond, . .	0.11	15.09	1.93	.0134	.0196	.0035	.0281	.0007	.0718	.94
Boston, . .	Mystic Lake, .	0.23	10.68	1.61	.0235	.0264	.0052	.0496	.0015	.1127	1.55
Average, .	. . . . .	0.33	8.13	1.61	.0097	.0304	.0113	.0228	.0005	.0811	0.60

From the analyses of the twenty-six waters arranged in Table No. 1, we learn that waters shown by their chlorine, as well as known in general by their surroundings, to be entirely unpolluted by sewage, may have nitrogen in its several forms in limited but quite varying amounts ; in some forms exceeding the amounts which have been regarded by chemists as indicating dangerous pollution by sewage. This is most marked with the albuminoid ammonias, of which many exceed 0.0200 parts in 100,000, and one reaches 0.0409 parts ; while the average, 0.0156 parts, exceeds a commonly accepted standard, above which water has been regarded as dangerous to health.

Seeking the source of these high albuminoid ammonias, we find that, when accompanied with high color, the waters have generally flowed through swampy districts, or have been in reservoirs having vegetable matter on the bottom. Others having less color have had abundant growths of algæ and other forms of life, which in turn depend upon nitrogen obtained from the rain and from organic matter, and nitrates brought into the ponds by surface or subterranean streams, or from organic matter in the mud at the bottom.

While these large albuminoid ammonias indicate organic matter whose origin is independent of sewage, and consequently is not likely to contain the germs of disease, which are regarded as the most dangerous element of sewage ; and while the albuminoid ammonias are, as in all of these waters, accompanied by low free ammonias, the

organic matter which they indicate may be regarded as in a state not readily susceptible to decay, and therefore not dangerous to health; we have yet to recognize the fact that many of these waters, unpolluted by sewage, have at times had bad odors and disagreeable tastes, which have rendered them unsuitable for drinking. These times have generally been in the warm weather, during or after an abundant growth of algæ or other organisms; and these objectionable tastes and odors have, in the waters of this and the next following series, been limited to those whose albuminoid ammonias have been above or a very little below the average of these series.

We may then conclude that surface waters, shown by their chlorines and by their drainage areas to be unpolluted by sewage, which have albuminoid ammonias less than the average of these series, or less than 0.0160 parts per 100,000, are much preferable to those having higher albuminoid ammonias; as the latter are more likely to have at times disagreeable tastes and odors.

The free ammonias of this series include one having 0.0069 parts, which is far higher than all of the others; the next lower being 0.0026, and the average of all being 0.0011 parts; three-quarters of the whole number being below the average. The highest free ammonia was that of a reservoir which was an overflowed meadow, which had been in use less than two years, when observations were commenced. Its water, during the greater part of the year, had very low free ammonia, sometimes 0.0000; but in the latter part of the summer, after there had been a considerable growth of algæ, the free ammonia increased greatly. Other instances of this kind will be discussed in a subsequent section.

The nitrates, in this series of unpolluted waters, reached in one case 0.0196 parts; but were generally much lower, and averaged 0.0060 parts; and the nitrites reach as high as 0.0002 parts, but are generally 0.0001 or less. The color, increasing in general with the albuminoid ammonia, although not following it closely, averages 0.27 on our scale of colors, and varies from 0.00 to 1.36. The total residue on evaporation reaches as high as 7 38 in the limestone district in the western part of the State, but is generally nearer the average, which is 4.03 parts, per 100,000. The loss on ignition averages 1.04 parts, and varies from 0.35 parts to 2.08 parts.

Turning to Table No. 2, in which are 27 water supplies having so little excess of chlorine above the normal that we are in doubt

whether they are in the least polluted by sewage, — the excess not being greater in any case than 0.03 part, which is generally less than the probable error of the normal chlorine, and if correct shows a pollution by sewage of only a fraction of one per cent, — we find variations similar, in kind and in amount, to those of the first series, and the averages of each series are almost identical in every respect. They are as follows: —

	Color.	Total Residue.	Loss on Ignition.	Free Ammonia.	Albuminoid Ammonia.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Total Nitrogen.
Average of Table No. 1,	0.27	4.03	1.04	0.0011	0.0156	0.0060	0.0001	0.0326
Average of Table No. 2,	0.33	3.95	1.06	0.0012	0.0169	0.0064	0.0001	0.0352

This second series, which, as has been said, contains waters having so little excess of chlorine that we are in doubt whether they are in the least polluted by sewage, confirms by its identity the reasonableness of regarding the average of the first series as expressing, in a general way, the relative amounts of the different forms of nitrogen that may be found in the unpolluted surface waters of the State; bearing in mind that there may be extreme cases in which the amounts of nitrogen, in the different forms, may be from two to three times the amount given in the average. These two series, containing 53 sources, include more than half of the surface water supplies of the State.

While the variations from the above averages of nitrogen extend to two or three times these amounts, it will be seen that, with the exception of the albuminoid ammonia, the amounts are so small that, in the highest, the free ammonias, the nitrates and the nitrites are low.

With the actual condition of the water supplies unpolluted by sewage, before us, we will turn to those in which an excess of chlorine shows that the waters have been in contact with household wastes. But first let us inquire what we have reason to expect to find. Let us consider the change that would be made in the chemical constituents of our stream of unpolluted water, if sewage like that described on page 538 should enter it, in sufficient quantity to form five per cent. of its volume. The sewage may enter directly, or it may enter after percolating through the ground and becoming more or less purified.

The constituents of the sewage were as follows: —

Free Ammonia.	Albuminoid Ammonia.	Chlorine.	Nitrates.	Nitrites.
1.8202	0.5302	5.25	0.0000	0.0000

From experiments upon intermittent filtration of this sewage, continued day after day for a year, through five feet of sand, we have found that the chlorine was not decreased, but that the forms of nitrogen were so changed as to give the following average results.

When slowly percolating through fine sand, under favorable conditions: —

Free Ammonia.	Albuminoid Ammonia.	Chlorine.	Nitrates.	Nitrites.
0.0014	0.0080	5.25	1.0404	0.0002

When more rapidly percolating through coarse sand: —

Free Ammonia.	Albuminoid Ammonia.	Chlorine.	Nitrates.	Nitrites.
0.0544	0.0265	5.25	1.5010	0.0013

If five per cent. of these constituents should be added to the stream, we should have the following additions to the constituents of the stream.

When sewage ran directly into the stream: —

Free Ammonia.	Albuminoid Ammonia.	Chlorine.	Nitrates.	Nitrites.	Total Nitrogen.
0.0910	0.0265	0.26	0.0000	0.0000	0.1181

When very completely purified by intermittent filtration through the ground: —

Free Ammonia.	Albuminoid Ammonia.	Chlorine.	Nitrates.	Nitrites.	Total Nitrogen.
0.0001	0.0004	0.26	0.0520	0.0000	0.0527

When less completely purified by intermittent filtration through the ground: —

Free Ammonia.	Albuminoid Ammonia.	Chlorine.	Nitrates.	Nitrites.	Total Nitrogen.
0.0027	0.0013	0.26	0.0750	0.0001	0.0794

If we should add these constituents to the unpolluted stream, containing the following: —

Free Ammonia.	Albuminoid Ammonia.	Excess of Chlorine.	Nitrates.	Nitrites.	Total Nitrogen.
0.0011	0.0156	0.00	0.0060	0.0001	0.0326

we should, in the first case, of direct discharge of sewage, find the chlorine increased by the full amount of 0.26 parts. The nitrates and nitrites would not be changed; but the albuminoid ammonia would be nearly trebled, the free ammonia would be enormously increased, and the total nitrogen would be more than trebled. The characteristics of the result would be the definite increase in chlorine, a very marked increase in total nitrogen, and an enormous increase

in free ammonia. The increase in albuminoid ammonia, though great, might not be sufficient to be characteristic.

Such a result should not be expected in the public drinking water supplies in this State, where, under the statute, no sewage from water-closets or from privies can be turned into any stream — except into two or three large rivers — within twenty miles above where its water is used for drinking; but, if such a result is found, search should be made for sewage thus entering, and the statute enforced.

When the sewage of the drainage area is put into the ground at each house, it enters intermittently, and has commonly a long distance to percolate before reaching the stream. In such case we might reasonably look for a result approximating to that of the second case of very complete purification of the sewage before it entered the stream. In this case, we should have the definite increase of 0.26 in the chlorine, and a very marked increase in the nitrates; an increase that would, under different circumstances, vary, but might reach to one-quarter or one-fifth of the increase of the chlorine. The definite and marked increase in the chlorine, in the nitrates and in the total nitrogen, would be characteristic of this condition, the change in the free and albuminoid ammonia being so slight as to be insignificant.

In the third case, of less complete purification while passing through the ground, which undoubtedly is the more common condition on the drainage area of our water supplies, we should have the same definite increase of the chlorine, and the very marked increase of the nitrates and of the total nitrogen, as in the second case. The increase in the albuminoid ammonia, being so small a percentage of that of the unpolluted stream, would not be characteristic; but the increase in the free ammonia, though not large in itself, is sufficiently large, when compared with what we may expect in the unpolluted stream, to indicate its source. The increase in the nitrites, though small, is significant.

Reviewing the several conditions, we find that, in all, the excess of the chlorine above the normal for the region indicates that nearly a definite percentage of the water of the stream has been, at some time, associated with household wastes. It may be, however, that that water has, before entering the stream, been so purified by filtering through the ground that little or none of its objectionable organic matter remains. If it has not been so purified, but enters the stream directly as sewage, we expect to find a large increase in the total

nitrogen, made up of a very large increase in the free ammonia, and a much smaller and less characteristic increase in albuminoid ammonia, with no change in the nitrates and nitrites.

If, on the other hand, it has been purified, by having the organic matter burned up while it was passing through the ground, we should expect to find less increase in the total nitrogen, made up of a very marked increase in the nitrates, with no appreciable increase in the albuminoid ammonia; but with an increase in the free ammonia, more or less marked, as purification by filtration was less or more complete.

There is another class of conditions which modifies these results, to a noticeable extent in streams, and often to a very marked extent in ponds and reservoirs: it is the vegetable and animal growth in the pond. Plants appropriate the ammonia and the nitrates, and may reduce the amount of nitrogen in a water, that shows by its chlorine to have been associated with household wastes, so that it becomes less than that ordinarily found in unpolluted ponds. When the organic matter, which was originally sewage, has been thus transformed, it is of course harmless, and the excess of chlorine indicates only what has been.

Plants growing upon the bank may remove the nitrogen permanently from the water, but plants growing upon the bed and floating plants retain the nitrogen for a time, and when they decay return it to the water as free ammonia.

Microscopic organisms in suspension may also reduce for a time the ammonia and the nitrates, and, being included in the sample analyzed, increase, by their substance, the albuminoid ammonia.

These modifications of the general results, attributable to the introduction of sewage into a water supply, vary with the season of the growth and decay of organisms; a study of which may be found in a previous chapter.

Turning to the remaining analyses of surface water supplies, we find thirty-three sources in which the excess of chlorine varies from 0.04 to 0.25 parts per 100,000; which indicates that from one to five per cent. of their volumes was made up of water from sewage having the strength of chlorine we have been considering. These are contained in Table No. 3. The average of these analyses is as follows: —

Color.	Total Residue.	Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid.	Excess of Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Total Nitrogen.
0.36	4.22	1.17	0.0021	0.0201	0.10	0.0101	0.0002	0.0449

Comparing this with the average of unpolluted waters given in Table No. 1, which was: —

Color.	Total Residue.	Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid.	Excess of Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Total Nitrogen.
0.27	4.03	1.04	0.0011	0.0156	0.0	0.0060	0.0001	0.0326

The increase is: —

Color.	Total Residue.	Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid.	Chlorine.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Total Nitrogen.
0.09	0.19	0.13	0.0010	0.0045	0.10	0.0041	0.0001	0.0123

There is an increase in each form of nitrogen, that of the free ammonia and nitrites being the amount that might be expected if the sewage were reasonably well purified by filtering through the ground. The increase in nitrates is less and in albuminoid ammonia more than such filtration would produce, due probably to the subsequent action of microscopic plants which appropriated the nitrates and increased by their substance the albuminoid ammonia.

There is no indication, in this general summary, of sewage being discharged directly into these sources; and the reduction in the quantity of the organic matter of the sewage, and the modifications through which it has passed, indicate that, chemically, there is very little ground for concluding that harm could result from the addition of this two per cent. in volume of what had been sewage. Whether germs of disease, that possibly were in the sewage, have been able to resist the great changes that have taken place, is not known.

While we find in this group, as a whole, an increase in total nitrogen of a little more than one-third of that in our group of unpolluted waters, we do not find it in form that indicates that sewage came directly — without filtration, or material modification by organic life — into these sources; and yet, upon examining the different sources, we find two into which we know sewage has been directly discharged. These are the Merrimack River at Lowell and at Lawrence; and we find, in both, the amounts of nitrogen in its several forms are less than the average of the group.

These sources, then, demand more careful consideration. The excess of chlorine, over that which belongs to the whole area which they drain, was found to be 0.06 parts at Lowell and 0.07 parts at Lawrence. We know that this river receives chlorides, in large quantity, from some of its manufacturing establishments; and we must turn to the number of persons living on the drainage area to determine how much of the chlorine indicates sewage. The esti-

mated population on the drainage area above Lowell, at the time of the observations, was 58 per square mile, and above Lawrence, was 80 per square mile.

If twenty persons per square mile ordinarily add 0.01 part to the chlorine as stated on page 680, the excess of chlorine due to sewage, at Lowell, would be 0.03 parts, and at Lawrence, 0.04 parts; and the excess above this of 0.03 parts, which makes up the observed excess, must be attributed to the manufacturing establishments.

The excess of chlorine, due to sewage, is, then, but about one-third of that of the average of the group, and indicates that about seven-tenths of one per cent. of the water in the river had been sewage.

We have now to see how much of the sewage probably came directly into the river without purification; and, in doing this, will limit consideration to Lawrence, whose water receives the greatest amount of such sewage. The estimated number of people on the whole drainage area above Lawrence, whose sewage is discharged directly into the river, or into some of its branches, is 165,000. If 60 gallons of sewage per person enter daily, there would be 10,000,000 gallons a day, or 15.5 cubic feet per second. The actual flow of the river, on the days when samples were taken, averaged 9,579 cubic feet per second; hence the sewage entering directly would amount to 0.0016 of the water of the river. About one-half of this sewage enters ten miles above Lawrence, and the remainder more than thirty miles above; each above long reaches of ponds made by dams. In these ponds there is abundant opportunity for a part of the organic matter of the sewage to settle, to become oxidized, or to be appropriated by plants and organisms in the river. If this amount of sewage were added to this quantity of water, with no chemical change or appropriation by organisms, we might expect an increase in free ammonia of 0.0029 parts, and in albuminoid ammonia of 0.0008 parts, or 0.0037 parts of total nitrogen; and, if our river were previously like our average of unpolluted streams having the following amounts of nitrogen, —

Free Ammonia.	Albuminoid Ammonia.	Nitrates.	Nitrites.	Total Nitrogen.
0.0011	0.0156	0.0060	0.0001	0.0326

there would result: —

Free Ammonia.	Albuminoid Ammonia.	Nitrates.	Nitrites.	Total Nitrogen.
0.0040	0.0164	0.0060	0.0001	0.0363

while the actual composition of the water of the river at Lawrence was as follows: —

Free Ammonia.	Albuminoid Ammonia.	Nitrates.	Nitrites.	Total Nitrogen.
0.0022	0.0178	0.0096	0.0003	0.0409

While in this case the large proportionate increase in the free ammonia above that of our unpolluted water indicates the addition of sewage, and the high nitrites indicate recent pollution not completely oxidized or converted into nitrates, we must still conclude that the direct addition of only one-sixth of one per cent. of sewage to a stream cannot, after the river has flowed from ten to thirty miles, be distinguished with certainty by chemical tests alone; we must have in addition the actual circumstances of the case, to give due weight to the several indications. The quantity of sewage added becomes so greatly diluted and modified, while so large a quantity of water is flowing in the river, that, under the conditions of high water for the two years of these observations, this water compares favorably with the poorer half of the surface water supplies of the State; and the amount of impurity is so small that, as chemical substances, they can do no harm; but we have yet to learn whether disease germs, entering with the sewage, under these circumstances, can survive the passage of ten miles down the river.*

It must be kept in mind, in regard to such sources, that they grow worse from year to year, and especially that in time of drought the sewage continues in full quantity, while the river water grows rapidly less. At such time, too, while the modifying conditions, such as the appropriation by plants, may affect the same amount of water, they would leave a larger portion of impurity unchanged. This was illustrated when the first low water occurred after the above observations, in August, 1890; when the flow in the river was only 2,300 cubic feet per second, or about one-quarter of the average given above, the free ammonia — the characteristic ingredient of sewage — increased to 0.0160 parts, or to nearly eight times the average previously found, and the albuminoid ammonia increased to 0.0216 parts. Here it is evident that a much smaller fraction of the entering sewage was modified in its passage down the river, and it may reasonably be assumed that at such time disease germs are more likely to reach this source.

* Note. — The prevalence of typhoid fever in Lowell in the fall and winter of 1890, followed about a month later by its prevalence in Lawrence, gives strong ground for concluding that, even with great dilution by high water in the river, the germs of this disease are able to survive the passage of ten miles in these months.

Turning to the other sources in this group, we find Van Horn Reservoir, Springfield, has the highest free ammonia, 0.0098 parts, with 0.05 excess of chlorine. This is a peculiar source, and requires a more detailed study than we have yet been able to give to it. Most of its water is received from Ludlow Reservoir, whose excess of chlorine is only 0.01 part; and we have not yet found sufficient sewage on the drainage area of Van Horn Reservoir to account for the increase of 0.04 parts in chlorine, nor for the increase of 0.0079 parts in the free ammonia.

The next high free ammonia is that of Buckmaster Pond, supplying Norwood. The high free ammonias were at a time of low water, and were accompanied with high chlorine — the excess reaching 0.14 parts — and with low nitrates; all of which would indicate that household wastes, or washings from manured land, enter this source quite freely; although the extremely high free ammonia in the winter of 1888 probably occurred at that time because of the decay of organisms which had, in the summer, settled to the bottom, and risen, with the turning over of the water, in winter.

Reservoir No. 3, of Sudbury River supply to Boston, has nitrogen in its different forms as follows: —

Free Ammonia.	Albuminoid Ammonia.	Excess of Chlorine.	Nitrates.	Nitrites.	Total Nitrogen.
0.0049	0.0285	0.19	0.0218	0.0003	0.0729

Our average of unpolluted streams was as follows: —

Free Ammonia.	Albuminoid Ammonia.	Excess of Chlorine.	Nitrates.	Nitrites.	Total Nitrogen.
0.0011	0.0156	0.00	0.0060	0.0001	0.0326

The excess above that of unpolluted streams, here, is as follows: —

Free Ammonia.	Albuminoid Ammonia.	Excess of Chlorine.	Nitrates.	Nitrites.	Total Nitrogen.
0.0038	0.0129	0.19	0.0158	0.0002	0.0403

If the excess came from sewage poured directly into the reservoir, we might expect it to be as follows: —

Free Ammonia.	Albuminoid Ammonia.	Excess of Chlorine.	Nitrates.	Nitrites.	Total Nitrogen.
0.0680	0.0199	0.19	0.0000	0.0000	0.0885

If the sewage were imperfectly filtered, we might expect it to be as follows: —

Free Ammonia.	Albuminoid Ammonia.	Excess of Chlorine.	Nitrates.	Total Nitrogen.
0.0020	0.0010	0.19	0.0562	0.0595

and, if very completely purified by filtration, we might expect it to be as follows : —

Free Ammonia.	Albuminoid Ammonia.	Excess of Chlorine.	Nitrates.	Total Nitrogen.
0.0001	0.0003	0.19	0.0390	0.0396

The excess of 0.19 parts of chlorine indicates that about four per cent. of the water has received as much salt as ordinary sewage. A part of the total nitrogen of the organic matter that would accompany that amount of salt has, without doubt, been appropriated by vegetable and animal growth which is not in the water. The part which is in the water, expressed by the excess above that of unpolluted streams, is in such form that we must conclude that all of it has not been completely purified by intermittent filtration through the ground, but that a part of it has flowed quite directly, with imperfect purification, from the household wastes, into this source.

Winchester Storage Reservoir has an excess of chlorine of 0.13 parts, and an average free ammonia of 0.0033 parts. As the watershed was reported uninhabited, these results indicating household wastes or washings from manured lands, caused further examination to be made, which showed that a portion of the village of Stoneham extends into the extreme upper end of the watershed, with a sufficient population to account for the excess of chlorine and the free ammonia.

Stony Brook Storage Reservoir, of Cambridge. This water has an excess of chlorine of 0.09 parts, which is greater than would be expected from a population of 90 to the square mile on its drainage area.

Its nitrogen is as follows : —

Free Ammonia.	Albuminoid Ammonia.	Excess of Chlorine.	Nitrates.	Nitrites.	Total Nitrogen.
0.0033	0.0286	0.09	0.0151	0.0002	0.0649

The excess above our unpolluted stream is as follows : —

Free Ammonia.	Albuminoid Ammonia.	Excess of Chlorine.	Nitrates.	Nitrites.	Total Nitrogen.
0.0022	0.0130	0.09	0.0091	0.0001	0.0323

Like Basin No. 3 of Boston's supply, this indicates that a part of the water, bearing the salt, has flowed quite directly with imperfect purification from household wastes or from manured fields, into this source ; but this was a new reservoir, filled for the first time during these observations, and, in common with some other new reservoirs,

the highest free ammonias were during and soon after filling. During the last fourteen months they averaged only two-thirds as much, and thus placed this water with those whose contributions from household wastes have been reasonably, but not very completely, purified by filtration.

Hingham, Fulling Mill Pond. This is so near the sea that there is doubt in regard to the excess of chlorine. Its high free ammonia was confined to the fall of 1887. The water was then drawn off, and the bottom cleaned, after which the free ammonia averaged 0.0005 parts from May to December, 1888, with no indication that sewage entered without being thoroughly purified.

Quincy Storage Reservoir. This drainage area is so near the sea that there is doubt in regard to the excess of chlorine. The records cover only five months after the reservoir was filled, in which the free ammonia averaged 0.0025 parts. There are but few inhabitants upon the watershed, and there has been more impurity in the water of the reservoir than in the water of the brook entering; hence the reported condition may be a temporary one. Longer series of observations will be necessary to establish the permanent character of this supply.

Lake Cochituate has, for the two years, had nitrogen in its different forms as follows: —

Free Ammonia.	Albuminoid Ammonia.	Excess of Chlorine.	Nitrates.	Nitrites.	Total Nitrogen.
0.0026	0.0207	0.20	0.0148	0.0003	0.0512

The excess above our average of unpolluted streams is as follows: —

Free Ammonia.	Albuminoid Ammonia.	Excess of Chlorine.	Nitrates.	Nitrites.	Total Nitrogen.
0.0015	0.0051	0.20	0.0088	0.0002	0.0186

With nearly the same excess of chlorine as the water of Reservoir No. 3, the excess of nitrogen, in its several forms, is only about four-tenths as much; and the result is nearly what would be expected if the sewage which supplied this chlorine had been imperfectly filtered through the ground, with a subsequent reduction of the nitrates by microscopic vegetable growths, which appear in the analysis as albuminoid ammonia. But the condition here illustrates the difficulty and sometimes the impossibility of distinguishing between a small quantity of sewage imperfectly filtered in the ground, before entering the pond, and the same quantity of sewage the most of which is very well filtered with a small portion entering

directly without filtration. During these observations sewage from perhaps 1,000 people entered the southern division of the lake, but it was so modified in character during its slow passage for about three miles from section to section of the lake, separated by narrow channels, that when it reached the northern division where the samples were collected the analyses do not enable us to distinguish it from sewage imperfectly filtered through the ground.

Westborough Storage Reservoir. The drainage area of this source is mostly wood-land, and has a very small population; its excess of chlorine is small, and yet the average free ammonia is higher than should accompany the chlorine, and indicates decaying organic matter in the pond or entering it without being purified. The observations were, however, continued but one year, and, in this time, a dam was built across the pond, and the mud and vegetable matter were removed from one section, which was afterwards filled with water and used as the source of supply. In the last three months of the observations, after the disturbance due to the changes had passed, there was no excess of chlorine, and the different forms of nitrogen were not unlike, in amount, those of unpolluted sources.

The remaining sources of this group have free ammonia less than the average of the group; and, if any of this comes from sewage entering the source directly, it is in so small quantity, or becomes so modified by the changes due to new organic growth in the water, that it can no longer be distinguished as imperfectly purified sewage.

We are, however, up to the present time unable to say how much these conclusions may be modified by a season of drought; because, in each year covered by the observations, the rainfall has been unusually large.

We have remaining seven sources of surface water supplies, in which the excess of chlorine exceeds 0.25 parts. The first of these, Lake Saltonstall in Haverhill, has an excess of 0.30 parts, and has so low ammonias and nitrates that it can be classed with the preceding cases, in which the sewage has been reasonably well purified before entering the pond.

The next, Hobart's Pond in Whitman, has an excess of chlorine of 0.31 parts per 100,000, and is of distinctly different character from the last. Its total nitrogen is nearly three times as much as the last, and more than three times as much as the average of the sources unpolluted by sewage. Its albuminoid ammonia is higher than the highest of the unpolluted sources, and only a

small part of it is made up of organisms in suspension. The high color indicates that much of it is from shallow flowage of vegetable deposit. Its free ammonia is much more in excess of the average of unpolluted waters than would be due to the amount of sewage indicated by the chlorine, if it were in the condition which we have called reasonably well purified by filtration. This is in part due to the periodical formation of free ammonia by the decay in the pond of vegetable organisms; but the free ammonia continues higher, through nearly the whole year, than in unpolluted sources. We must conclude that the villages in the drainage area of this source contribute sewage more directly, and with much less complete purification by filtration, than in most of the previously considered water supplies; and the consequent danger from disease germs not being destroyed is presumed to be greater.

The next source, Jamaica Pond, has about the same excess of chlorine, viz., 0.33 parts, and has still higher total nitrogen, indicating pollution; and its average free ammonia for the two years is very much greater, being 0.0157 parts. This by itself would indicate direct entrance of some of the sewage; but the quantity of water contained in this pond is equal to the whole quantity flowing into it in three years, hence any impurities which enter may in the long time be appropriated by organic growths in the water, which in their turn decay and give out ammonia, so that the only way to determine whether sewage enters the pond directly is to thoroughly examine the surroundings, which has not been done.

During the time of abundant growth of organisms the free ammonia of the water, about six feet below the surface, becomes very low and is sometimes reduced to zero. These organisms, growing and dying through the summer, settle to the bottom, where, by slow decay, they generate ammonia; and, when in the late fall and winter, by change in temperature of the water, the bottom water comes to the surface, it brings with it free ammonia amounting to 0.0300 or 0.0400 parts per 100,000.

That the high albuminoid ammonia is due to microscopic organisms, is indicated by the fact that about three-quarters of it is in suspension. The peculiarities of this source are so marked that they are made the subject of study in a subsequent section.

The next source is the Arlington Storage Reservoir, in which the excess of chlorine is 0.36 parts. Its total nitrogen is higher than any we have considered, being, however, nearly all contained in its

albuminoid ammonia, — 0.0475 parts, — and nitrates, — 0.0246 parts, — while its free ammonia is only 0.0024 parts.

This reservoir having a muddy bottom, and the drainage area being largely meadow land, some of which is overflowed to a slight depth, we should expect, if there were no pollution from dwellings, nearly as high albuminoid ammonia. The high color also indicates the swampy origin of the albuminoid ammonia. The low free ammonia and high nitrates indicate that the sewage is well purified by filtration before entering the reservoir.

The next source, Dug Pond in Natick, has an excess of chlorine of 0.44 parts. Its total nitrogen is not as high as in the three preceding sources, and it has a larger proportion of nitrates. This, and the comparatively low free ammonia, as ordinarily found in the analyses, indicate, that, while a considerable percentage of the water has been in contact with household wastes, it has been reasonably though not completely purified by filtration through the ground, and has been modified by organic growth in the pond.

The next source, Fresh Pond in Cambridge, has a much higher excess of chlorine, owing to the large population within its drainage area. This average, however, includes a time of transition from a natural pond receiving water from its own drainage area to a reservoir receiving most of its water from a comparatively uninhabited district. We will consider its condition as shown by the analyses of its waters during five months, when it was a natural pond. The average analysis at that time was as follows: —

Color.	Total Residue.	Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid.	Excess of Chlorine.	Nitrates.	Nitrites.
0.02	17.40	1.93	.0015	0.0147	1.69	0.0300	–

These analyses indicate that at that time, although the excess of chlorine was very great, there was no direct entrance of sewage into the pond, and that all water that had been in contact with household wastes had been well purified. It is, however, possible that, in the season of rapid growth, included in these five months, entering organic matter may have been so rapidly appropriated by the organisms in the water that it would not appear in the analysis. If so, the water was, at that time, thus purified, and it would require a complete examination of the surroundings to determine with certainty whether any sewage entered the pond without being purified in the ground.

We now reach the last source, Mystic Lake of the Boston water supply, which has the extremely high excess of chlorine of 1.55 parts per 100,000. This excess cannot be attributed entirely to household wastes, because some of the tanneries in this watershed are far from sewers, and the chlorine from their wastes, from working salt hides, must ultimately enter the stream. We have not, then, in this case, our ordinary measure of water from household wastes.

The population upon this drainage area, not provided with sewers, is about 820 per square mile, which, with our estimate of 20 per square mile for each 0.01 part excess of chlorine, would give an excess of chlorine of 0.41 parts per 100,000, leaving 1.14 parts to be contributed by other sources.

We do not know how much organic matter would accompany the latter portion of the chlorine. We find here the highest total nitrogen in any of the sources, and much of this in the objectionable form of free ammonia, indicating much pollution, and very incomplete purification. A much more elaborate study of the several streams which supply this water to the lake would be necessary to determine to what extent the organic matter of the household and manufacturing wastes is made over into new forms before the water is drawn from the lake.

During the warm months, when the algæ and other organisms are growing rapidly, and the surface water does not sink, the free ammonia of the incoming organic matter appears to be appropriated by such growth, and thus reduced to about one-third of the average amount, indicating a good degree of purification at such time.

As the cold weather comes on, the surface water, growing colder than that at the bottom of the pond, sinks, and the bottom water rises, bringing with it the results of decaying organic matter from the bottom, increasing the free ammonia in the water drawn from the pond to nearly three times that of the average for the year.

This high free ammonia indicates here, as well as in sewage, a state of decay; and, although the nitrogen of this decaying organic matter may have, in large part, come from sewage, we are unable to say whether any disease germs, that may have been associated with it in sewage, have been able to survive the various changes that have occurred. The strongest ground for concluding that they have not survived is, that a community is daily drinking this water, and is

not known to be troubled, more than other communities, with the diseases attributed to disease germs.

Such a conclusion presents no ground for safety under unusual conditions, such as an epidemic of a germ disease upon this drainage area, or the introduction of a disease whose germs are better adapted to survive the changes that are here taking place.

Ground Waters.

The water supplies of the State, derived directly from springs, which are shown, by their chlorine and from the absence of habitations upon their drainage areas, to be unpolluted by sewage, are few in number; but they are characteristic.

Those coming directly from the ground, and not exposed to sunlight, are arranged in the following table in the order of their nitrates: —

[Parts per 100,000.]

City or Town.	Source.	Color.	Residue on Evaporation.		Ammonia.			Nitrogen as		Total Nitrogen.	Excess of Chlorine.
			Total.	Loss on Ignition.	Free.	Albuminoid.		Nitrates.	Nitrites.		
						Total.	Sus-pended.				
Amherst, . .	Springs, . . .	0.00	2.98	-	.0001	.0024	-	.0067	.0000	.0107	.01
Mansfield, . .	Well, ...	0.00	2.73	-	.0000	.0014	-	.0083	.0000	.0106	.01
Uxbridge, . .	Covered reservoirs,	0.00	2.53	-	.0001	.0009	-	.0118	.0000	.0134	-
Warren, . .	Springs, . . .	0.00	4.10	-	.0000	.0011	-	.0242	.0001	.0261	.02
Williamstown, .	Spring, . . .	0.00	13.96	-	.0001	.0007	-	.0486	.0000	.0498	.00
Average, .	. . . . .	0,00	5.26	-	.0001	.0013	-	.0199	.0000	.0221	-

The characteristics of these ground waters are freedom from color; free ammonia and nitrites exceedingly small, or wanting; low albuminoid ammonia, and varying nitrates; with varying, but low, total nitrogen.

Another group of unpolluted ground waters, differing from the former in being exposed to sunlight after coming out of the ground, is contained in the following table: —

[Parts per 100,000.]

City or Town.	Source.	Color.	Residue on Evaporation.		Ammonia.			Nitrogen as		Total Nitrogen.	Excess of Chlorine.
			Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Sus-pended.	Nitrates.	Nitrites.		
Orange, . .	Spring, ...	0.05	3.10	–	.0000	.0075	–	.0030	–	.0153	.01
Agawam, . .	Springs, . . .	0.00	3.14	–	.0005	.0015	–	.0080	.0000	.0109	.03
Newton,* . .	Filter basin, . .	0.01	4.63	–	.0006	.0086	–	.0082	.0001	.0229	.02
Cheshire, . .	Storage reservoir, .	0.00	4.24	–	.0001	.0029	–	.0130	.0000	.0178	–
Ashburnham, .	Storage reservoir, .	0.02	2.52	–	.0003	.0077	–	.0191	.0001	.0321	.03
Newburyport, .	Well and tap in city,	0.03	5.39	–	.0004	.0032	–	.0312	.0001	.0367	.00
Average, .	. . . .	0.02	3.84	–	.0003	.0052	–	.0137	.0001	.0225	–

* If any considerable fraction of this supply comes from the river, whose normal chlorine is less than that of the locality, the excess of chlorine would be greater than here given, and this source would be excluded from this group.

From the preceding section, we bring for comparison the average analysis of our unpolluted surface waters: —

Color.	Total Residue.	Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid.	Nitrates.	Nitrites.	Total Nitrogen.
0.27	4.03	1.04	0.0011	0.0156	0.0060	0.0001	0.0326

Comparing the ground waters, unpolluted by sewage, with surface waters, we see the essential differences in the two classes. When they have the same amount of total nitrogen, the ground waters have only about one-tenth as much free and albuminoid ammonia, with five times as much nitrogen as nitrates. Whereas, in surface waters, the great variations in nitrogen were in the form of organic nitrogen, here we find that in ground waters the organic matter has been oxidized or burned in its passage through the ground, and the nitrogen, or a part of it, that existed in organic matter, now exists in mineral matter, as nitrates.

Experiments upon intermittent filtration, of both sewage and water, show that the total amount of nitrogen found in water after it has percolated through the ground and become nitrified is less than when it was on the surface, by twenty-five or fifty per cent.; and here we find the total nitrogen in the unpolluted ground water, which contains the most, to be about two-thirds of the amount contained in the unpolluted surface water, which contains the most; and the same relation between the average total nitrogen of the ground and surface waters. From which we may conclude that our short

list of unpolluted ground waters includes nearly the whole range of the variation in total nitrogen, or of nitrates, that we are likely to find in unpolluted ground waters.

The average of the analyses of the first group is as follows: —

Color.	Total Residue.	Ammonia. Free.	Ammonia. Albuminoid.	Nitrates.	Nitrites.	Total Nitrogen.
0.00	5.26	0.0001	0.0013	0.0199	0.0000	0.0221

In the second group of unpolluted ground waters, which have been slightly modified by exposure to light, the total nitrogen averages almost exactly the same as that of the first group; but the different forms of nitrogen are proportioned differently.

The average analysis of the six sources is as follows: —

Color.	Total Residue.	Ammonia. Free.	Ammonia. Albuminoid.	Nitrates.	Nitrites.	Total Nitrogen.
0.02	3.84	0.0003	0.0052	0.0137	0.0001	0.0225

Here the nitrates are reduced, and the albuminoid ammonia increased by about the same amount of nitrogen. This is, without doubt, due to the appropriation of nitrates by the microscopic vegetable organisms found in most of these waters, which, in the substance of these organisms, becomes organic nitrogen, and appears in the analyses of the water as albuminoid ammonia.

The close agreement in the total nitrogen of these two groups of unpolluted waters, — and this being, as we should expect, about two-thirds of the total nitrogen of the unpolluted surface waters, — enables us reasonably to conclude that the above average analysis of unmodified ground waters expresses nearly the relation of the different forms of nitrogen to be found in unpolluted ground waters, but that in extreme cases the quantity of each form may be from two to two and a half times the average quantity.

Before examining the different forms of nitrogen in the waters taken from the ground, which, by an excess of chlorine, show that they have been polluted by sewage, we will first take all of such waters and compare their excess of chlorine with their excess of total nitrogen above 0.0221 parts per 100,000, or above the average found in our unpolluted ground waters.

They have been placed in the following table, in the order established by the number of times the excess of total nitrogen is contained in the excess of chlorine: —

City or Town.	Source.	Excess of Total Nitrogen over .0221. A	Excess of Chlorine. B	Ratio. B/A
Wayland, ...	Filter gallery, ...	.0526	.08	1.52
Ware, ...	Well, ...	.2790	.52	1.87
Stoughton, ...	Well, ...	.8175	1.79	2.19
Dedham,*	Well, ...	.2458	.64	2.60
Chicopee Falls, . . .	Springs, ...	.0400	.11	2.75
Kingston, ...	Well and gallery, ...	.0812	.23	2.83
Wellesley, ...	Filter gallery, ...	.0397	.12	3.02
Franklin, ...	Wells, ...	.2036	.67	3.29
Concord Reformatory, . .	Wells, ...	.9415	3.20	3.40
Sharon, ...	Well, ...	.1676	.59	3.52
Ayer, ...	Well, ...	.0437	.17	3.89
Middleborough, . . .	Well, ...	.1378	.54	3.92
Arlington, ...	Filter gallery, ...	.0792	.32	4.04
Easton, ...	Well, ...	.0370	.15	4.05
Hopkinton, ...	Wells, ...	.3904	1.69	4.33
Chicopee, ...	Springs, ...	.0238	.11	4.62
Braintree, ...	Filter gallery, ...	.0809	.43	5.32
Grafton, ...	Wells and springs, ...	.2404	1.34	5.57
Milford, ...	Wells, ...	.0114	.07	6.14
Watertown,*	Filter gallery, ...	.0378	.28	7.41
Whitman, ...	Filter gallery, ...	.0359	.28	7.80
Hyde Park,*	Wells near river, ...	.0463	.37	7.98
Bridgewater,* . . .	Wells near river, ...	.0127	.11	8.66
Attleborough,* . . .	Filter gallery and wells, . .	.0863	.81	9.38
Waltham,*	Filter basin, ...	.0155	.16	10.32
Framingham, ...	Filter gallery, ...	.0217	.23	10.60
Brookline,*	Filter gallery, ...	.0147	.17	11.43
Taunton,*	Filter basin, ...	.0120	.19	15.83
North Attleborough, . .	Well near pond and river, . .	.0126	.26	20.63
Woburn, ...	Filter gallery, ...	.0194	2.05	105.77

* The normal chlorine used for these wells and galleries near rivers is the normal for the locality. If the relative quantity of water received into the gallery from the river and from the land side had been known, the normal for their mixture could have been determined. This would have been in all of these cases somewhat less than that used, thus making the excess and the ratio somewhat greater than here given.

The first and last in the table are exceptional. The first, which cannot properly be called a ground water, is from a gallery close by the shore of an unpolluted surface water, which contains an extremely large amount of total nitrogen; and the last is from a gallery by

the shore of a pond which has received a large excess of chlorine from tanneries treating salted hides.

Of the remaining sources, we find that all in which the excess of total nitrogen is less than one-sixth of the excess of chlorine are filter galleries or wells on the banks of streams or ponds from which they derive much of their water. Although their waters are taken out of the ground, they differ from true ground waters. They are surface waters which have been strained and in some cases purified by passing through porous material.

There are two conditions which generally exist with all of these ground water supplies. The first is that the location is generally selected so far from any apparent source of pollution, by sewage, that such polluted water flows through the ground intermittently, and becomes more or less purified by oxidation, converting the organic matter into nitrates, as in intermittent filtration. These nitrates are soluble, and the larger part of their nitrogen is taken along to the source of supply, and makes up a part of the total nitrogen.

The other condition is, that, under the statute in Massachusetts, no sewage from water-closets or privies can be turned directly into any stream or pond on the banks of which, for a distance of twenty miles below, there is a filter basin from which water is used for drinking. On this account the sewage of the inhabitants on the watersheds of the streams and ponds, near which our filter galleries are situated, first goes into the ground, and is to a considerable extent purified, before it enters the stream; while in the stream or pond, growing organisms, both animal and vegetable, appropriate a part of the nitrogen, and, when the water is again passed through sand, on its way to the gallery, these organisms are excluded, and the total nitrogen is reduced. Each of these processes, of a change of form, or removal, of nitrogen, is an important step in the purification of the water from the original pollution by sewage. In these steps there is no decrease in the chlorine; hence we find that, when the water has passed through the two processes of purification, there is much less excess of total nitrogen in proportion to the excess of chlorine than when it has passed through but one process, as in the more properly called ground waters.

The latter are to be found in the upper part of the table, and contain an excess of total nitrogen from one-half to one-sixth of the excess of the chlorine.

When the excess of chlorine is more than this, we may look, for the source of the water, to a surface water from which a part of the nitrogen has been removed, or to a source of pollution in which more chlorine enters than usually accompanies sewage, as may be found in some manufacturing wastes.

Turning to the extreme case of the intermittent filtration of sewage, we find, from the results obtained at the Lawrence Experiment Station, that when, as in the ordinary condition, the total nitrogen of the sewage was about one-half as many parts per 100,000 as the chlorine, the effluent that was regarded as very completely purified contained one-fifth as much total nitrogen as chlorine, and the effluent that was less completely purified contained about one-third as much total nitrogen as chlorine.

From this general view we will turn to the examination of the several sources of ground water supplies that are shown, by their excess of chlorine, to have been, at some time, polluted by sewage.

Of the ground waters which are shown, by their chlorine, to have from one to five per cent. of their volume of water which had been in contact with household wastes, we find eleven sources, which give the following average analysis : —

Color.	Total Residue.	Ammonia. Free.	Ammonia. Albuminoid.	Excess of Chlorine.	Nitrates.	Nitrites.	Total Nitrogen.
0.02	5.16	0.0004	0.0034	0.15	0.0467	0.0001	0.0523

The average analysis of the unpolluted ground water was : —

Color.	Total Residue.	Ammonia. Free.	Ammonia. Albuminoid.	Excess of Chlorine.	Nitrates.	Nitrites.	Total Nitrogen.
0.00	5.26	0.0001	0.0013	0.00	0.0199	0.0000	.0221

and the average increase, with an excess of chlorine of 0.15, is as follows : —

Color.	Total Residue.	Ammonia. Free.	Ammonia. Albuminoid.	Excess of Chlorine.	Nitrates.	Nitrites.	Nitrogen.
0.02	0.10	0.0003	0.0021	0.15	0.0268	0.0001	0.0302

Taking the same character of sewage that we introduced in discussing surface waters, we shall find that an increase of 0.15 parts per 100,000 in chlorine would, if the sewage were poured directly into the source without purification, increase the several forms of nitrogen as follows : —

Free Ammonia.	Albuminoid Ammonia.	Nitrates.	Nitrites.	Total Nitrogen.
0.0546	0.0159	0.0000	0.0000	0.0708

If very completely purified, by filtration, as follows: —

Free Ammonia.	Albuminoid Ammonia.	Nitrates.	Nitrites.	Total Nitrogen.
0.0001	0.0002	0.0310	0.0000	0.0314

If less completely purified by filtration: —

Free Ammonia.	Albuminoid Ammonia.	Nitrates.	Nitrites.	Total Nitrogen.
0.0016	0.0008	0.0450	0.0000	0.0476

The increase in total nitrogen of this group is just one-fifth of the excess of chlorine, which is the relation which exists in our very complete purification by filtration. The small free and albuminoid ammonias indicate that no sewage comes directly, without purification, into these sources. The greater increase in the free and albuminoid ammonias and the less increase in nitrates than we would expect with the very complete purification indicated by the total nitrogen suggests that some of these sources are exposed to the light, and that some are surface waters that have been purified a second time by passing through the ground.

The analyses of the water, from the several sources, are given in the following table: —

Analyses of Ground Water Supplies which contain an Excess of Chlorine of from 0.07 Parts to 0.26 Parts per 100,000, arranged in the Order of their Nitrates.

City or Town.	Source.	Color.	Residue on Evaporation.		Ammonia.			Nitrogen as		Total Nitrogen.	Excess of Chlorine.
			Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Suspended.	Nitrates.	Nitrites.		
Milford,	Wells,	0.01	3.71	–	.0000	.0031	–	.0283	.0001	.0335	.07
Waltham,*	Filter basin,	0.00	6.62	–	.0008	.0045	–	.0292	.0003	.0374	.16
Brookline,*	Filter gallery,	0.03	6.79	–	.0003	.0041	–	.0299	.0000	.0363	.17
Bridgewater,*	Wells,	0.02	4.20	–	.0011	.0016	–	.0312	.0001	.0348	.11
No. Attleborough,	Well,	0.00	6.23	–	.0001	.0014	–	.0315	.0000	.0347	.26
Chicopee,	Sand Bank Pond,	0.00	3.75	–	.0006	.0056	–	.0407	.0001	.0459	.11
Chicopee Falls,	Springs,	0.18	4.17	–	.0004	.0091	–	.0467	.0002	.0621	.11
Easton,	Well,	0.00	4.28	–	.0002	.0016	–	.0563	.0000	.0591	.15
Wellesley,	Filter gallery,	0.00	6.45	–	.0002	.0022	–	.0580	.0000	.0618	.12
Ayer,	Well,	0.00	5.16	–	.0004	.0017	–	.0626	.0001	.0658	.17
Kingston,	Well and filter gallery,	0.00	5.39	–	.0002	.0021	–	.0995	.0002	.1033	.23
Average,		0.02	5.16	–	.0004	.0034	–	.0467	.0001	.0523	.15

* See note at bottom of table, page 705.

Upon examination of those among these sources which are not exposed to light, they are found to contain but about one-half as much free and albuminoid ammonia as those which are exposed to the light.

Four of these sources — Waltham, Brookline, Bridgewater and North Attleborough — are filter galleries or wells, on the banks of rivers. Their excess of total nitrogen is from one-eighth to one-nineteenth of their excess of chlorine, because they have been doubly purified, first as surface waters, and then, to a good degree, though not very perfectly, as ground waters. If this last process had been more complete, their free and albuminoid ammonias would have been somewhat lower. We must, however, conclude that these waters have been very well purified from the sewage pollution that at some time entered them.

Four of the sources — Chicopee Falls, Kingston, Wellesley and Ayer — have excess of total nitrogen about one-third of their excess of chlorine, which, together with their free and albuminoid ammonias, places them a little below those which we have called very completely purified by filtration.

The remaining sources — Easton, Chicopee (exposed to light) and Milford — indicate, by their total nitrogen and their ammonias, that they are very completely purified by filtration.

From experiments made at Lawrence, it appears reasonable to conclude that, when polluting organic matter has become so completely nitrified as in these cases, which we have called very completely purified by filtration, the bacteria that accompanied the polluting organic matter are destroyed.

Our next group contains twelve sources of supply, in which the excess of chlorine is above 0.26 parts.

The several analyses are as follows : —

Ground Waters in which the Excess of Chlorine is above 0.26 Parts per 100,000, arranged in the Order of Nitrates.

City or Town.	Source.	Color.	Residue on Evaporation. Total.	Residue on Evaporation. Loss on Ignition.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Sus-pended.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Total Nitrogen.	Excess of Chlorine.
Watertown,*	Filter gallery,	0.00	6.98	–	.0002	.0035	–	.0540	.0000	.0599	.28
Hyde Park,*	Tubular wells,	0.00	6.10	–	.0002	.0019	–	.0649	.0002	.0684	.37
Braintree,	Filter gallery,	0.07	7.14	–	.0006	.0045	–	.0984	.0003	.1030	.43
Attleborough,*	Well,	0.02	9.13	–	.0016	.0032	–	.1007	.0011	.1084	.81
Middleborough,	Well,	0.00	8.61	–	.0002	.0023	–	.1559	.0001	.1599	.54
Sharon,	Well,	0.00	7.99	–	.0001	.0007	–	.1884	.0001	.1897	.59
Franklin,	Well,	0.01	8.77	–	.0001	.0015	–	.2230	.0002	.2257	.67
Grafton,	Gallery,	0.00	10.76	–	.0002	.0023	–	.2585	.0001	.2625	1.34
Dedham,*	Well,	0.00	10.57	–	.0002	.0012	–	.2658	.0000	.2679	.64
Ware,	Well,	0.00	7.51	–	.0030	.0011	–	.2991	.0002	.3011	.52
Hopkinton,	Tubular wells,	0.00	14.67	–	.0001	.0017	–	.4095	.0001	.4125	1.69
Stoughton,	Well,	0.01	17.34	–	.0013	.0040	–	.8280	.0040	.8396	1.79
Average,	. . .	0.01	9.63	–	.0004	.0023	–	.2455	.0005	.2499	.81

* See note at bottom of table, page 705.

The average of this group has the following excess above the average of our unpolluted ground waters: —

Color.	Residue on Evaporation.	Free Ammonia.	Albuminoid Ammonia.	Nitrates.	Nitrites.	Total Nitrogen.	Excess of Chlorine.
0.01	4.37	.0003	.0010	.2256	.0005	.2288	.81

If we omit the two which have the highest free ammonia, the average of the group would be: —

Free Ammonia.	Albuminoid Ammonia.	Nitrates.	Nitrites.	Total Nitrogen.	Excess of Chlorine.
.0002	.0021	.2017	.0001	.2051	.71

The excess above the average of unpolluted waters would be: —

Free Ammonia.	Albuminoid Ammonia.	Nitrates.	Nitrites.	Total Nitrogen.	Excess of Chlorine.
.0001	.0008	.1818	.0000	.1840	.71

The excess of the total nitrogen being but about one-quarter of the excess of chlorine, and this being nearly all in the harmless form of nitrates, and the excess of free and albuminoid ammonias being so very small, we must regard the water of the group, as it stands after the omissions, as very completely purified.

Examining these sources in detail, we find three of them — Watertown, Hyde Park and Braintree — have low total nitrogen in proportion to their chlorine, because they receive water freely from a surface water near, and the low ammonias of the first two indicate that they belong in the class indicated by the group; but the average given in the table for Braintree, and the still higher ammonias found in the spring and early summer of 1887 and 1888, indicate that there are times when this water is not so well purified.

All of the other sources, having ammonias so little in excess of unpolluted waters, — although in some cases their excess of total nitrogen is a very large fraction of the excess of chlorine, — must be regarded as very completely purified by filtration.

Returning to the two sources omitted on account of their higher free ammonia, we find that one of them — Attleborough — has a filter gallery and wells by the side of Ten Mile River. The low excess of nitrogen, being but one-ninth of the excess of chlorine, would place this water among the surface waters again purified; but the excess of the chlorine of the gallery above that of the river, shows that free communication does not exist; and the only explanation that appears probable is that most of the polluted water comes so far through the ground that it is very completely purified, but that a small percentage comes from a short distance, and is imperfectly purified, and thus brings with it more of ammonia than we should expect from the small amount of total nitrogen. This conclusion is confirmed by the unusually high nitrites of this source.

The other omitted source is that of Stoughton, a well thirty feet deep in the centre of the village. The excess of total nitrogen is very large, compared with the excess of chlorine, and both indicate that the water has been very seriously polluted by sewage; but the small ammonias indicate that it has, in general, been well purified, although not what we have called very completely purified, by filtration. An increase in the ammonias and in the nitrites in the winter of 1887–88 shows a less purification at that time, and indicates danger in the use of a water which has been so highly charged with organic matter, and which depends, for its purification, upon circumstances that vary from time to time.

We have two other sources of ground waters exhibiting peculiarities which it would be well to compare. One is from the Woburn Filter Gallery, on the shore of Horn Pond, and the other from wells at the State Reformatory at Concord, which receive water filtered

from the sewage of the institution. These wells are not now used as a source of water supply.

The average analyses are as follows : —

City or Town.	Source.	Color.	Residue on Evaporation.		Ammonia.			Nitrogen as		Total Nitrogen.	Excess of Chlorine.
			Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Sus-pended.	Nitrates.	Nitrites.		
Woburn, .	Filter gallery, . . .	0.00	11.78	–	.0011	.0029	–	.0358	.0000	.0415	2.05
Concord, .	State Reformatory wells,	0.01	20.22	–	.0194	.0039	–	.9400	.0013	.9636	3.20

In the first case, we find the excess of chlorine is one hundred times the excess of nitrogen over that of unpolluted waters; and, in the second case, the excess of chlorine is but three and four-tenths times as much as the excess of the total nitrogen.

The relation of the excess of chlorine and the excess of the different forms of nitrogen, in the second case, is what we should expect from the filtration of sewage, when the purification ranges between that which we have called very complete purification, and that called reasonably well purified by filtration. This is shown by the following results.

Proportion of nitrogen in different forms, when diluted sewage is very completely purified by filtration : —

Free Ammonia.	Albuminoid Ammonia.	Chlorine.	Nitrates.	Nitrites.	Total Nitrogen.
0.0008	0.0048	3.20	0.6242	0.0001	0.6324

When reasonably well purified by filtration : —

Free Ammonia.	Albuminoid Ammonia.	Chlorine.	Nitrates.	Nitrites.	Total Nitrogen.
0.0326	0.0159	3.20	0.9000	0.0008	0.9536

The excess of nitrogen in the different forms found in the State Reformatory wells, above that of unpolluted waters, is as follows : —

Free Ammonia.	Albuminoid Ammonia.	Chlorine.	Nitrates.	Nitrites.	Total Nitrogen.
0.0193	0.0026	3.20	0.9201	0.0003	0.9403

Turning to the supply from Woburn Filter Gallery, we find the following excess above unpolluted ground waters : —

Free Ammonia.	Albuminoid Ammonia.	Chlorine.	Nitrates.	Nitrites.	Total Nitrogen.
0.0010	0.0016	2.05	0.0159	0.0000	0.0193

Whence this great excess of chlorine with the very small excess of total nitrogen? It is without doubt due to two causes: a great

increase of chlorine from the soakings from tanneries treating salt hides, and a decrease of the nitrogen by its appropriation by the great abundance of algæ and other organisms growing in the pond, which are filtered out, by the sand, between the pond and the filter gallery.

The chlorine of the filter gallery indicates that about eight-tenths of its water is from the pond; and the reduction of the free and albuminoid ammonias to about eight per cent. of those in the pond, shows a good degree of purification in the passage; so that this water, that has contained much pollution, from the large population upon the drainage area and from the manufacturing wastes, must be regarded as approaching near to the condition of being very completely purified.

We have remaining a group of five waters, taken from the ground, which are, in fact, imperfectly filtered surface waters. Their excess of total nitrogen is generally very small, but varies from more than one-half to one-fifteenth of the excess of chlorine.

The analyses are given below: —

Imperfectly filtered Surface Waters, arranged in the Order of Free Ammonia.

City or Town.	Source.	Color.	Residue on Evaporation.		Ammonia.			Nitrogen as		Total Nitrogen.	Excess of Chlorine.
			Total.	Loss on Ignition	Free.	Albuminoid. Total.	Albuminoid. Sus-pended.	Nitrates.	Nitrites.		
Taunton,	Filter basin,	0.39	5.47	–	.0012	.0102	–	.0163	.0001	.0341	.19
Framingham,	Filter gallery,	0.07	5.93	–	.0031	.0084	–	.0272	.0003	.0438	.23
Whitman,	Filter gallery,	0.33	5.51	–	.0100	.0188	–	.0186	.0004	.0580	.28
Wayland,	Filter gallery,	0.50	4.96	–	.0140	.0186	–	.0325	.0002	.0747	.08
Arlington,	Filter gallery,	0.24	6.80	–	.0148	.0173	–	.0603	.0005	.1013	.32
Average,	. . . .	0.31	5.73	–	.0086	.0147	–	.0310	.0003	.0622	.22

These sources are filter basins or galleries on the shore of ponds or streams, so near that the partially purified water passes freely and continuously, without exposure to air, through the bank of sand and gravel, so that there is no opportunity, or very little opportunity, for the nitrifying effect of intermittent filtration.

In fact, the nitrates of the surface waters adjacent, which supply nearly all of the water of these galleries, average 0.0144 parts, while the nitrates within the galleries average 0.0310 parts, which

is only about one-half of what we should expect, if the same waters were well purified by intermittent filtration. And this increase is in part due to the nitrification of sewage matter in the soil, on the land side of the filter galleries. This is evident from the greatest increase in the nitrates being where the excess of chlorine is greatest in the filter gallery, above that of the surface water adjacent.

To observe the effect of this imperfect filtration, the several forms of nitrogen, and the excess of chlorine above the normal, of the surface water adjacent to the filter gallery, and of the water in the filter gallery, are given in the following table : —

City or Town.	Source.	Ammonia.		Excess of Chlorine.	Nitrogen as		Total Nitrogen.	Excess of Chlorine Divided by Excess of Total Nitrogen.
		Free.	Albuminoid.		Nitrates.	Nitrites.		
Taunton, . .	River, . . .	.0019	.0284	.12	.0084	.0001	.0566	5.17
	Filter basin, . .	.0012	.0102	.19	.0163	.0001	.0341	15.83
Framingham, . .	Farm Pond, . .	.0047	.0262	.18	.0158	.0003	.0629	6.10
	Filter gallery, .	.0031	.0084	.23	.0272	.0003	.0438	10.60
Whitman, . .	Hobart's Pond, .	.0061	.0435	.30	.0122	.0003	.0888	5.41
	Filter gallery, .	.0100	.0188	.28	.0186	.0004	.0580	7.79
Wayland, . .	Reservoir, . .	.0020	.0298	.00	.0108	.0001	.0614	–
	Filter gallery, .	.0140	.0186	.08	.0325	.0002	.0747	1.52
Arlington, . .	Reservoir, . .	.0024	.0475	.36	.0246	.0002	.1047	5.05
	Filter gallery, .	.0148	.0173	.32	.0603	.0005	.1013	4.04
Average, . .	River or pond, .	.0034	.0351	.19	.0144	.0002	.0750	4.59
	Filter gallery, .	.0086	.0147	.22	.0310	.0003	.0622	5.48

The principal effect of the imperfect filtration, in these cases, is, like continuous filtration of sewage generally, to reduce the albuminoid ammonia and increase the free ammonia, the sum of both being reduced by what is strained out. There is wanting the presence of air in the ground through which the water passes, to enable the ammonia to be still further removed by its oxidation and conversion into nitrates.

We have remaining four sources of ground waters so near the sea that we are unable to determine their normal chlorine, and have not our usual measure to determine to what extent they have been in contact with household wastes. In such case we fall back upon the total nitrogen to indicate what has been, and its present form to indicate the actual condition.

The analyses are given in the following table: —

Ground Waters collected so near the Sea that the Normal Chlorine is indeterminate, arranged in the order of nitrates.

City or Town.	Source.	Color.	Residue on Evaporation.		Ammonia.			Nitrogen as		Total Nitrogen.	Actual Chlorine.
			Total.	Loss on Ignition.	Free.	Albuminoid. Total.	Albuminoid. Sus-pended.	Nitrates.	Nitrites.		
Cohasset,	Wells,	0.00	14.46	–	.0002	.0020	–	.0272	.0003	.0309	1.55
Revere,	Wells,	0.00	22.55	–	.0001	.0019	–	.1408	.0024	.1464	3.41
Malden,	Tubular wells,	0.00	16.69	–	.0000	.0005	–	.4768	–	.4769	2.20
Swampscott,	Wells,	0.01	25.01	–	.0013	.0032	–	.4786	.0003	.4852	3.28
Average,	. . . .	0.00	19.68	–	.0004	.0019	–	.2808	.0010	.2852	2.61

The average of the different forms of nitrogen is as follows: —

Free Ammonia.	Albuminoid Ammonia.	Nitrates.	Nitrites.	Total Nitrogen.
0.0004	0.0019	0.2808	0.0010	0.2852

The average of the same for our unpolluted ground waters was: —

Free Ammonia.	Albuminoid Ammonia.	Nitrates.	Nitrites.	Total Nitrogen.
0.0001	0.0013	0.0199	0.0000	0.0211

The total nitrogen being fourteen times that of our unpolluted waters, shows that this group has at some time been in contact with organic matter in large amount; but this being nearly all in the form of nitrates, and the ammonias being so slightly in excess of those of unpolluted waters, we see that filtration has removed nearly every vestige of the former organic matter; that is, has burned it all up, and left only mineral nitrates.

This is particularly the case with the sources of Cohasset, Revere and Malden, where the free ammonias have, nearly all of the time, been zero; but with the Swampscott wells there has not been this permanence of purification. On one occasion the free ammonia increased to 0.0202 parts, indicating too free communication with the foul water of Stacy's Brook that flows near, or with sewage from the surrounding habitations. Since that occasion, which was in October, 1887, there has been one occasion when the free ammonia was found to be 0.0038, and the albuminoid ammonia 0.0108 parts, with much lower nitrates than usual, indicating imperfect purification and danger in this source.

The relation between the chemical composition of a water and its healthfulness as a drinking water is one concerning which we must speak with much reserve, since, in the first place, the cases are not as numerous as we could wish in which we are positive as to the causal connection between drinking waters and disease; and, secondly, because in many of the recorded cases in which such a connection seems to have been made out the chemical analysis of the water is wanting. The organic matter found in the surface waters of this State, which are unpolluted by sewage, is generally of so permanent character that it may be regarded as not detrimental to health, and, until we have more complete knowledge of this subject, it seems reasonable to assume that, when, by the increase in chlorine, it becomes evident that sewage has been added to a surface water, the increase in the amount of organic matter, due to the sewage, may be taken as indicating its probable harmfulness.

In unpolluted ground waters the amount of organic impurity is so small that it may be disregarded; and, of any ground water shown by an excess of chlorine to have been polluted by sewage, we may assume that the harmfulness of the water is in direct proportion to its organic impurity, and that danger from its use decreases in proportion as its purification progresses. Whether the organic matter or the products of its decomposition are to be regarded, in themselves, as the cause of disease, or whether harmful germs are to be credited with the evil effects of the water, the assumption applies equally well, since the conditions involved in the complete purification of the water are those which are inimical to the life of the micro-organisms.

DISCUSSION OF SPECIAL TOPICS

RELATING TO THE

QUALITY OF PUBLIC WATER SUPPLIES.

By FREDERIC P. STEARNS,

ENGINEER OF THE BOARD,

AND

THOMAS M. DROWN, M.D.,

CHEMIST OF THE BOARD.

DISCUSSION OF SPECIAL TOPICS

RELATING TO THE

QUALITY OF PUBLIC WATER SUPPLIES.

The large number of instances in which public water supplies have been affected by bad tastes and odors point either to a lack of information on the part of those charged with the selection of the sources of the water and the construction and maintenance of works with regard to the causes of these troubles, or to some difficulty in obtaining a satisfactory supply at a reasonable cost, inherent in the situation of the municipalities supplied. An examination of specific cases where troubles have commonly occurred, shows that the former cause is responsible for the difficulties in a majority of instances. This result is not surprising, when we consider that the water supplies are very varied in character, and in different situations are subject to trouble from different causes; also, that there has been a lack of systematic and continuous observations and of a means of diffusing information. As a consequence, works which have furnished unsatisfactory water in one place have been duplicated in another, so that water supplies which are unsatisfactory from similar causes are found in different parts of the State.

The investigations of the State Board of Health, up to the present time, do not, by any means, solve all of the problems regarding the selection of water supplies and the maintenance of the water in a palatable condition; but they do solve some of them, and throw light on others. It is the purpose of this portion of the report to present results which have especial reference to these subjects.

THE EFFECT OF STORAGE.

In a few instances it has been found practicable to obtain a supply of surface water from a stream which, at all seasons of the year,

will furnish the required quantity of water without resorting to storage; but in a great majority of cases, it is necessary to obtain a supply from water stored in a pond, or to construct a storage reservoir which will supply any deficiency in the natural flow of the stream during dry seasons. Even where a supply is taken directly from a stream, or drawn from the ground, it is generally found best to provide a distributing reservoir or tank, in which some water can be stored for emergencies, and thus obviate the necessity of continuous pumping. The effect of storage under various conditions is, therefore, a matter of much importance. Water is stored under a great variety of circumstances, and the source and character of the water have an important bearing upon the effect of this storage. This is particularly noticeable where ground waters are stored in open distributing reservoirs.

The effect of storage can be ascertained both by chemical and by microscopical examinations. In chemical analysis it is best indicated by the changes which occur in the nitrogen compounds, particularly the albuminoid ammonia which represents the organic, and the nitrates which represent the bulk of the inorganic, nitrogen. For instance, a rise in albuminoid ammonia and a reduction in the amount of nitrates due to storage, are occasioned by an increase of organic matter which is often accompanied by bad tastes and odors. Microscopical examinations of the water before and after storage indicate the changes in the number and kind of organisms.

The conditions of storage are so varied, and the results depend so much upon the character of the water, that the different classes will be considered separately.

Storage of Surface and Ground Waters in Distributing Reservoirs and Tanks.*

Surface Waters Stored in Open Distributing Reservoirs.

Analyses have been made of samples of water taken simultaneously from ponds or storage reservoirs, and from the correspond-

* For the purposes of this discussion, distributing reservoirs are assumed to include only such as are excavated in the ground and lined with earth, stone or masonry. They are generally quite large in area, and contain from fifteen to twenty feet in depth of water. Tanks, on the other hand, are structures of iron built above ground, varying greatly in the ratio of diameter to depth of water, some having a diameter in excess of the depth, so that, if not covered, the water is freely exposed to the light; while in other cases the depth of water is very great in proportion to the height, and, even if open at the top, the amount of light which can reach the water, particularly the bottom layers, is much restricted.

ing distributing reservoirs. The reservoirs selected for comparison are at Marlborough, Gardner, Danvers, Salem, Norwood and Boston; the comparison at the latter place being made between the waters of the Chestnut Hill and Fisher Hill reservoirs. The observations were continued for a year, but the nitrites were determined for only a portion of the time. The mean result of all observations is indicated by the following comparison: —

Comparison of Analyses of Waters in Six Ponds and Storage Reservoirs with the Same Waters after being Pumped and Held in Open Distributing Reservoirs.

	Ponds or Storage Reservoirs.	Open Distributing Reservoirs.
Color,	0.20	0.20
Total residue on evaporation,	3.94	3.95
Free ammonia,	.0023	.0019
Albuminoid ammonia,	.0178	.0187
Nitrogen as nitrates,	.0077	.0077
Nitrogen as nitrites,	.0001	.0001
Chlorine,	.41	.42

There is no reason to expect any change in the total residue or chlorine, and this is practically the result of the comparison, the difference being no greater than may be attributed to errors of observation. The color might be expected to diminish somewhat, owing to the bleaching action of the sun; but the comparison shows the same depth of color in both places. Even in the nitrogen compounds, where we would naturally look for the greatest changes, we find that the nitrates and nitrites show no change whatever, and the ammonias show but little.

To ascertain whether changes of greater significance occurred at any particular season of the year, the following table has been prepared, which shows the changes by months: —

Average Analyses of Water of Six Ponds and Storage Reservoirs before and after being pumped and held in Open Distributing Reservoirs,— by Months.

MONTH.	FREE AMMONIA.			ALBUMINOID AMMONIA.			NITROGEN AS					
							NITRATES.			NITRITES.		
	Pond or Storage Reservoir.	Distributing Reservoir.	Change.	Pond or Storage Reservoir.	Distributing Reservoir.	Change.	Pond or Storage Reservoir.	Distributing Reservoir.	Change.	Pond or Storage Reservoir.	Distributing Reservoir.	Change.
January, . .	.0037	.0035	—.0002	.0174	.0186	+.0012	.0113	.0140	+.0027	.0001	.0000	—.0001
February, .	.0053	.0050	—.0003	.0217	.0185	—.0032	.0145	.0113	—.0032	.0001	.0001	.0000
March, . .	.0025	.0028	+.0003	.0183	.0175	—.0008	.0115	.0108	—.0007	.0002	.0001	—.0001
April, . .	.0021	.0015	—.0006	.0175	.0191	+.0016	.0110	.0147	+.0037	.0002	.0002	.0000
May, . .	.0010	.0011	+.0001	.0182	.0180	—.0002	.0080	.0090	+.0010	.0001	.0001	.0000
June, . .	.0020	.0013	—.0007	.0155	.0171	+.0016	.0063	.0043	—.0020	-	-	-
July, . .	.0013	.0009	—.0004	.0173	.0195	+.0022	.0032	.0035	+.0003	-	-	-
August, . .	.0011	.0006	—.0005	.0173	.0191	+.0018	.0043	.0023	—.0020	-	-	-
September, .	.0006	.0004	—.0002	.0187	.0200	+.0013	.0036	.0028	—.0008	-	-	-
October, . .	.0012	.0006	—.0006	.0176	.0215	+.0039	.0052	.0035	—.0017	-	-	-
November, .	.0026	.0028	+.0002	.0165	.0182	+.0017	.0055	.0065	+.0010	-	-	-
December, .	.0044	.0029	—.0015	.0180	.0177	—.0003	.0085	.0098	+.0013	-	-	-
Average, .	.0023	.0019	—.0004	.0178	.0187	+.0009	.0077	.0077	.0000	.0001	.0001	.0000

The above table shows a noticeable increase in the albuminoid ammonia during the warmer months; but, on the whole, it may be said that the changes produced by pumping the waters of these ponds or storage reservoirs, and holding them for a short time in open distributing reservoirs, are very small and of little practical significance. This is a result which might be anticipated where water before being pumped has already been subject to such change as storage in the open air would produce.

The foregoing comparisons were made with waters pumped from ponds and storage reservoirs, and only those cases were selected in which there was nothing to affect the results except the pumping and subsequent storage of the water. Observations have been made in five other instances in which some unusual features were present, so that these cases need to be considered individually. The conditions at the different places are as follows: —

Lawrence. — The supply is taken mainly from the Merrimack River, but a small quantity of water is also obtained from a filter-gallery. The waters from both of these sources mingle in the pump-well, and are forced thence to the reservoir. The samples were taken from the force main just beyond the pumps and from the outlet of the reservoir. The water, as it enters the reservoir, is aerated by falling over some granite steps. The river receives directly the sewage of Lowell, nine miles above Lawrence; also of other places, as described on pp. 173, 174 and 440–444, of this volume.

Lowell. — The situation at this place corresponds closely to that at Lawrence. The proportion of water coming from the filter-gallery is larger, and the river is less affected by sewage. The samples were collected from the conduit which conveys the mixed river and filter-gallery water to the pumping station, and from the outlet of the reservoir. The water is aerated by falling from two to six feet over a weir as it enters the reservoir.

New Bedford. — The water flows from the storage reservoir through a conduit five and five-eighths miles long to a receiving reservoir, and thence is pumped to the distributing reservoir. The water enters the latter by falling over a weir, and is thereby aerated. The samples were taken from the lower end of the conduit and from the distributing reservoir at the outlet gate house. The difference between the samples should therefore represent any change in the character of the water due to storage in two reservoirs, pumping and aeration.

Worcester, — *Leicester Supply.* — The water in this instance flows by gravity from the storage to the distributing reservoir, and is aerated as it enters the latter by being discharged from the top of a vertical pipe in the middle of the reservoir, which projects twelve feet above the water.

Boston, — *Mystic Supply.* — In this instance the works, when compared with the six first considered, present no unusual features, but the character of the water is subject to so great changes from time to time that the result of a comparison may not be trustworthy; moreover, on account of the large amount of nitrogen in various forms found in this water, greater changes may be expected to occur than in ordinary waters.

The changes occurring at these five places are indicated in the following table: —

Table showing Average Analyses of Surface Water before and after being conveyed to and held in Open Distributing Reservoirs.

City or Town.	Free Ammonia.			Albuminoid Ammonia.			Nitrogen as Nitrates.			Nitrogen as Nitrites.		
	At Source.	Distributing Reservoir.	Change.	At Source.	Distributing Reservoir.	Change.	At Source.	Distributing Reservoir.	Change.	At Source.	Distributing Reservoir.	Change.
Lawrence, .	.0026	.0029	+.0003	.0174	.0144	—.0030	.0135	.0146	+.0011	.0003	.0002	—.0001
Lowell, . .	.0032	.0028	—.0004	.0142	.0139	—.0003	.0170	.0177	+.0007	.0003	.0002	—.0001
New Bedford,	.0021	.0021	.0000	.0275	.0282	+.0007	.0163	.0134	—.0029	.0001	.0000	—.0001
Worcester, .	.0050	.0046	—.0004	.0163	.0161	—.0002	.0062	.0079	+.0017	.0000	.0001	+.0001
Boston, Mystic,	.0221	.0198	—.0023	.0266	.0247	—.0019	.0496	.0549	+.0053	.0015	.0013	—.0002

NOTE.—In this and subsequent tables the averages may not correspond exactly with those given for the same waters in the first portion of this report. There are two reasons for this; namely, additional analyses, made subsequently, are sometimes included; and interpolations have been made where a regular monthly observation was omitted or abnormal, so that all parts of a year might have equal representation.

The table shows that the chemical changes which take place at Lowell, New Bedford and Worcester are too small to have any special significance, notwithstanding the aeration which the water receives at each of these places.

At Lawrence there is a noticeable reduction in the amount of albuminoid ammonia, equal to seventeen per cent. of the amount in the water at the source. Corresponding to this there is a slight increase in the nitrates. The significance of this change becomes more apparent when the average analysis of water drawn from a tap in the city two miles from the reservoir and near the further end of the distributing system is also included in the comparison.

	Albuminoid Ammonia.	Nitrogen as Nitrates.
Water from force main, ...	.0174	.0135
Water from reservoir, ...	.0144	.0146
Water from tap in city, ...	.0117	.0192

It will be observed from the above that a change similar to that which takes place in the reservoir occurs to a more marked extent during the passage of the water through the pipes, so that, comparing the water drawn from the force main with that from the tap, we find there is a reduction of thirty-three per cent. in the albuminoid

ammonia, and an increase of forty-two per cent. in the nitrates. As the former represents the organic and the latter the inorganic and harmless form of nitrogen, it will be seen that a very considerable purification takes place in this instance after the water leaves the pumps.

At Boston, the changes due to pumping and holding water in the College Hill Reservoir of the Mystic Works are somewhat similar to those at Lawrence, as the free and albuminoid ammonias decrease and the nitrates increase. At both of these places where the greatest purification takes place, the waters are more affected by sewage than at any other of the places included in the comparisons. The Merrimack River above Lowell also receives sewage, so that a corresponding change might be expected in the water of that city; but the quantity of sewage is considerably less than at Lawrence, and it enters the river at more remote points, which may possibly account for the difference in the effect of storage in the two cases. There is also a difference in the size of the distributing reservoirs, that at Lawrence holding fifteen days' supply, and that at Lowell six days' supply.

Surface Waters stored in Open Tanks.

Only a few comparisons have been made to determine the effect of storage of this kind, as it seemed probable that the water would be affected to a less extent in tanks than in open reservoirs. The few examinations made indicate that the change, if any, in the character of the water due to such storage is small, and that it is beneficial rather than otherwise.

Ground Waters stored in Open Distributing Reservoirs.

As in the case of surface supplies, analyses have been made of waters collected simultaneously from ground water sources and from the open distributing reservoirs into which the water was pumped.

Observations have been made at twelve places, and of these seven are selected where the water is pumped directly from a dark ground water source to an open reservoir. In six of these instances the examinations were continued for two years, and in the other for one year. The seven places selected are Brookline, Cohasset, Hyde Park, Kingston, Revere, Ware and Woburn. The average amount of the nitrogen compounds and the changes due to storage in an open reservoir are shown in the following tables. In

the first table the waters are tabulated by towns, so as to indicate the character of the different waters. In the second table the average analyses of all waters are tabulated by months, to show the changes due to the season of the year.

Table showing Average Composition of Ground Waters before and after being pumped and held in Open Distributing Reservoirs,—by Towns.

TOWN.	FREE AMMONIA.			ALBUMINOID AMMONIA.				NITROGEN AS					
				TOTAL.			SUSPENDED.	NITRATES.			NITRITES.		
	At Source.	In Distributing Reservoir.	Change.	At Source.	In Distributing Reservoir.	Change.	In Distributing Reservoir.	At Source.	In Distributing Reservoir.	Change.	At Source.	In Distributing Reservoir.	Change.
Brookline, .	.0003	.0003	.0000	.0041	.0171	+.0130	.0077	.0282	.0091	—.0191	.0000	.0001	+.0001
Cohasset, .	.0002	.0002	.0000	.0020	.0110	+.0090	.0049	.0274	.0047	—.0227	.0003	.0002	—.0001
Hyde Park, .	.0002	.0009	+.0007	.0019	.0189	+.0170	.0129	.0659	.0315	—.0344	.0002	.0002	.0000
Kingston, .	.0000	.0001	+.0001	.0020	.0058	+.0038	-	.1145	.1030	—.0115	-	-	-
Revere, . .	.0001	.0019	+.0018	.0020	.0070	+.0050	.0026	.1282	.1073	—.0209	.0024	.0018	—.0006
Ware, . .	.0000	.0015	+.0015	.0011	.0094	+.0083	.0031	.2991	.2655	—.0336	.0002	.0015	+.0013
Woburn, .	.0011	.0016	+.0005	.0029	.0088	+.0059	.0033	.0358	.0264	—.0094	.0000	.0003	+.0003
Average, .	.0003	.0009	+.0006	.0023	.0111	+.0088	.0057	.0999	.0782	—.0217	.0005	.0007	+.0002

Grouping together the average changes as given at the bottom of the table, we have the following:—

Free ammonia, ...	increase, .0006
Albuminoid ammonia, ...	increase, .0088
Nitrogen as nitrates, ...	decrease, .0217
Nitrogen as nitrites, ...	increase, .0002

The characteristic changes are the increase in albuminoid ammonia, fourteen-seventeenths of which is nitrogen, and the decrease in nitrogen as nitrates; that is to say, a part of the inorganic nitrogen in the ground water at its source has been appropriated by living organisms in the reservoir, which, with products of their life and decay, are indicated in an analysis by the albuminoid ammonia. There is an apparent loss of nitrogen as nitrates in excess of the increase of nitrogen as albuminoid ammonia, which is for the most part accounted for by the fact that only about one-half of the organic nitrogen in the water is obtained by the albuminoid ammonia process. Some of the organic nitrogen is also contained

in plants which are fixed to the bottom and sides of a reservoir, or in free organisms which have died and fallen to the bottom, so that it is not represented in a sample of water collected for analysis.

On account of the appropriation of nitrogen by the organisms, it might be inferred that the waters highest in nitrates would produce the most abundant growths with a corresponding increase in the amount of albuminoid ammonia; but an examination of the different waters shows that this is not the case. For instance, the nitrates are highest at Ware, with a change in albuminoid ammonia slightly below the average; while at Cohasset, where the nitrates are least, the reverse is true. On the whole, it may be said that the amount of nitrogen in a ground water, within the limits presented in the table, does not determine the amount of subsequent change in the character of the water when stored in an open reservoir.

Table showing Average Composition of Ground Waters before and after being pumped and held in Open Distributing Reservoirs, — by Months.

MONTH.	FREE AMMONIA.			ALBUMINOID AMMONIA.				NITROGEN AS					
				TOTAL.			SUSPENDED.	NITRATES.			NITRITES.		
	At Source.	In Distributing Reservoir.	Change.	At Source.	In Distributing Reservoir.	Change.	In Distributing Reservoir.	At Source.	In Distributing Reservoir.	Change.	At Source.	In Distributing Reservoir.	Change.
January, .	.0002	.0002	.0000	.0022	.0090	+.0068	.0050	.0968	.0941	—.0027	.0006	.0006	.0000
February, .	.0003	.0001	—.0002	.0027	.0082	+.0055	.0063	.0855	.0899	+.0044	.0006	.0006	.0000
March, . .	.0001	.0004	+.0003	.0024	.0106	+.0082	.0071	.1177	.0914	—.0263	.0003	.0006	+.0003
April, . .	.0001	.0008	+.0007	.0027	.0127	+.0100	.0075	.0913	.0829	—.0084	.0004	.0008	+.0004
May, . .	.0001	.0012	+.0011	.0020	.0138	+.0118	.0077	.1081	.0645	—.0436	.0004	.0009	+.0005
June, . .	.0006	.0018	+.0012	.0020	.0111	+.0091	.0055	.1061	.0721	—.0340	.0006	.0009	+.0003
July, . .	.0003	.0028	+.0025	.0024	.0104	+.0080	.0038	.1151	.0725	—.0426	.0005	.0007	+.0002
August, .	.0003	.0022	+.0019	.0025	.0110	+.0085	.0028	.0738	.0530	—.0208	.0005	.0007	+.0002
September, .	.0003	.0007	+.0004	.0022	.0114	+.0092	.0041	.1017	.0706	—.0311	.0006	.0008	+.0002
October, .	.0004	.0004	.0000	.0019	.0116	+.0097	.0062	.1152	.0823	—.0329	.0002	.0006	+.0004
November, .	.0003	.0003	.0000	.0018	.0115	+.0097	.0060	.0974	.0831	—.0143	.0006	.0005	—.0001
December, .	.0003	.0004	+.0001	.0026	.0123	+.0097	.0070	.0900	.0824	—.0076	.0008	.0005	—.0003
Average, .	.0003	.0009	+.0006	.0023	.0111	+.0088	.0057	.0999	.0782	—.0217	.0005	.0007	+.0002

In the above classification by months it will be noticed that the increase of total albuminoid ammonia due to storage is very nearly

uniform at all seasons of the year. The nitrates show a large reduction after the first two months of the year, although the amount is somewhat variable. The free ammonia shows a marked increase during the spring and summer, with scarcely any change during the remainder of the year. The nitrites show a slight increase in all of the warmer months. The general result of this tabulation is that a ground water stored in an open reservoir will deteriorate at all seasons of the year.

Ground waters of the class under consideration contain few if any microscopic organisms at their source; but, after storage in an open reservoir, the number is sometimes in excess of that found in any other source of water supply.

The above discussion has been confined to seven supplies out of twelve of this general class which have been examined. Of the five excluded, only one (Wellesley) shows results which are in any way contrary to those furnished by the seven supplies. At this place, according to the analyses given in the first part of this volume, there is an increase of nitrates due to storage. This apparent exception to the general rule is due to the fact that water is pumped to the reservoir from two sources which differ in the amount of nitrates, and all of the samples after the first four were taken from the source which contains the smaller amount.

Ground Waters stored in Covered Reservoirs and Tanks.

Observations to determine the effect of storing ground waters in tanks which are covered to exclude the light have been made at Brookline, Middleborough and North Attleborough, and the results are indicated in the following table: —

Table showing Average Composition of Ground Waters before and after being stored in Covered Tanks.

	Free Ammonia.			Albuminoid Ammonia.			Nitrogen as Nitrates.		
	At Source.	In Tank.	Change.	At Source.	In Tank.	Change.	At Source.	In Tank.	Change.
Brookline,	.0003	.0001	—.0002	.0041	.0044	+.0003	.0284	.0283	—.0001
Middleborough,	.0001	.0003	+.0002	.0022	.0024	+.0002	.1585	.1594	+.0009
North Attleborough,	.0002	.0002	.0000	.0018	.0017	—.0001	.0267	.0352	+.0085
Average,	.0002	.0002	.0000	.0027	.0028	+.0001	.0712	.0743	+.0031

The changes in free and albuminoid ammonia are so very small that they indicate definitely that ground waters when stored in covered tanks are not subject to any changes corresponding to those which they undergo when stored in open reservoirs. The nitrates appear to increase at North Attleborough, but, as there is no corresponding decrease in the other nitrogenous constituents, it is difficult to account for this except by supposing some unknown condition affecting the comparision.

The only place at which ground water is pumped to a covered distributing reservoir is at Kingston. This reservoir is fifty feet in diameter, and has vertical walls of brick masonry, the depth of water being eighteen feet. It was covered with a roof in July, 1888. Before this time the quality of the water was affected by storage as at other places, although to a less extent. Since the reservoir was covered, the water in it is shown by nearly all of the analyses made to be substantially the same as that at the source.

Ground Waters Stored in Open Tanks.

Observations have been made at Swampscott, Braintree and Sharon, where ground waters are pumped to tanks which are open at the top; also at Watertown, where the tank is covered over, but the light is not wholly excluded. The dimensions of the tanks are as follows: —

	Diameter.	Height.
Swampscott,	22.5 feet.	110 feet.
Braintree,	30 feet.	100 feet.
Sharon,	20 feet.	80 feet.
Watertown,	40 feet.	40 feet.

The analyses indicate that the water stored in these tanks does not undergo any material change.

Notwithstanding this result, it must not be assumed that water can be stored in all open iron tanks without deteriorating, as the one at Brookline before it was covered gave as much trouble from the growth of organisms as the open distributing reservoir. This tank is fifty feet in diameter and thirty feet high, so that it

admitted light much more freely than those above referred to. Since it was covered the water has been uniformly of as good quality as at the source, as indicated by the table on page 728.

Special Experiment upon the Storage of Ground Water at Hyde Park.

The storage of ground water in the open distributing reservoir at Hyde Park caused such offensive tastes and odors that the water company found it necessary to apply a remedy, and for a time in the spring of 1889 resorted to continuous pumping, thereby temporarily discontinuing the use of the reservoir. At this time an experiment was made as to the effect of storing water fresh from the pumps in the open reservoir where light would have free access to it, and in the gate-house where light was wholly excluded. As a preparation for the experiment, the water was drawn from the reservoir on two successive weeks, and each time it was cleaned as thoroughly as was practicable with a reservoir having a slope paving of stones laid without mortar. The gate-house was also cleaned, and the valves were arranged to isolate it from the reservoir and from the pipe system. After the gate-house and reservoir had been filled with water, the valves were closed and the pressure in the pipes was kept somewhat less than that in the gate-house, so as to prevent leakage from the former into the latter. The water in the gate-house lowered somewhat from day to day, indicating outward leakage; but, owing to this lowering, some water may also have leaked into the gate-house from the reservoir. Pumping into the reservoir began May 16, 1889, and ended May 22, when the reservoir was full. The first samples were collected May 24. The water was drawn out of the gate-house May 29, in order to stop a leak, and was replaced with fresh water; and again on July 10, when the experiment was nearly at an end, about eight inches in depth was drawn from the reservoir and replaced.

Analyses of water from the reservoir and gate-house are given in the following table: —

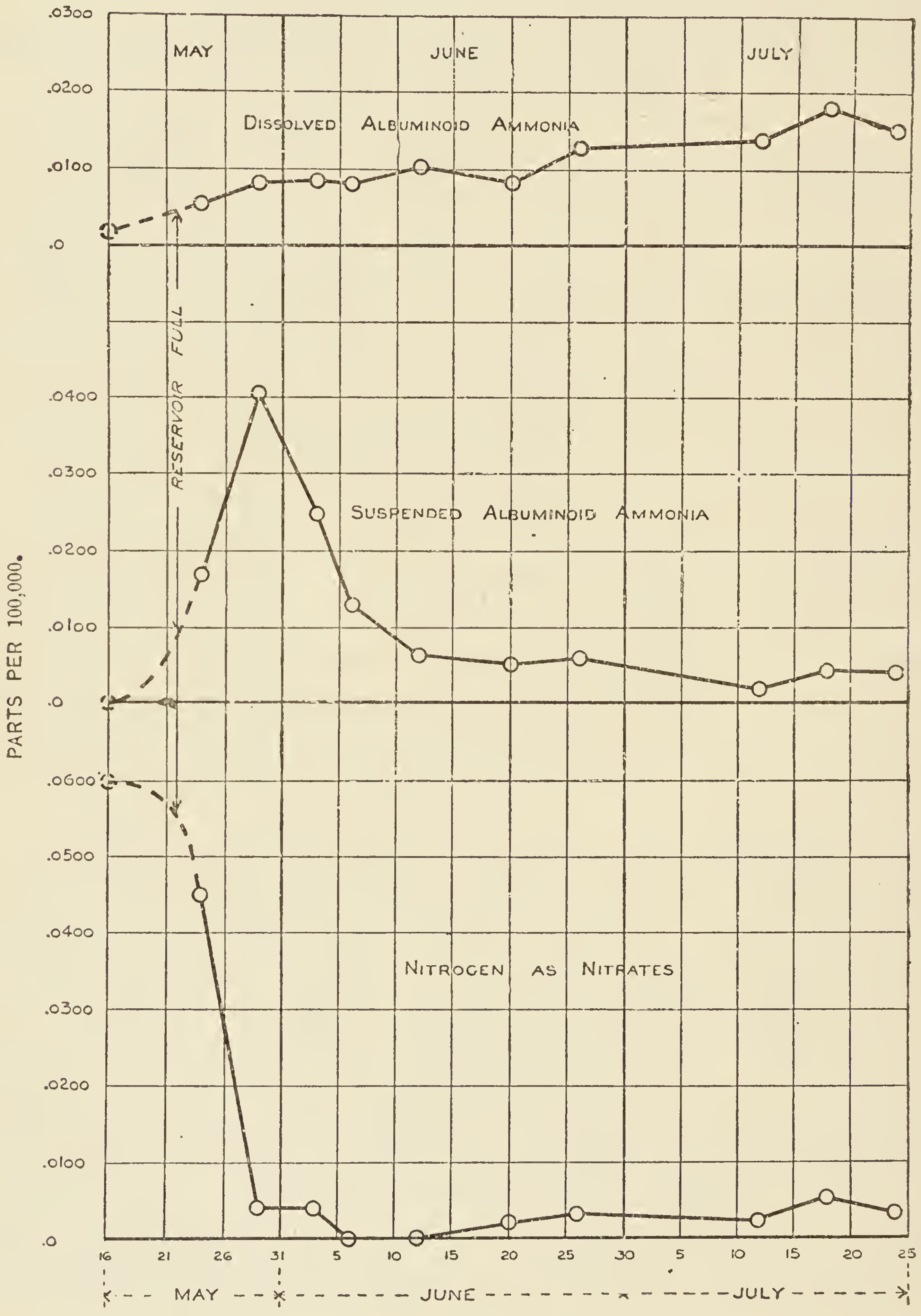
Analyses of Water from the Open Reservoir and Darkened Gate-house of the Hyde Park Water Company.

NOTE. — The water entering the reservoir is assumed to be of the same character as a sample obtained at the pumping station nine days before the filling of the reservoir was begun.

DATE — 1889.	Free Ammonia.		Albuminoid Ammonia.				Nitrogen as			
			Open Reservoir.			Gate-house.	Nitrates.		Nitrites.	
	Open Reservoir.	Gate-house.	Dissolved.	Suspended.	Total.	Total.	Open Reservoir.	Gate-house.	Open Reservoir.	Gate-house.
Water entering reservoir,	.0002	.0002	.0016	.0000	.0016	.0016	.0600	.0600	.0000	.0000
May 24, ...	.0020	.0006	.0054	.0170	.0224	.0054	.0450	.0600	.0009	.0002
May 29, ...	.0018	.0012	.0082	.0406	.0488	.0064	.0040	.0350	.0005	.0002
June 3, ...	.0000	.0022	.0086	.0248	.0334	.0052	.0040	.0500	.0001	.0003
June 6, ...	.0000	.0018	.0080	.0128	.0208	.0054	.0000	.0600	.0000	.0003
June 12, ...	.0014	.0028	.0102	.0064	.0166	.0048	.0000	–	.0000	.0004
June 20, ...	.0000	.0006	.0082	.0052	.0134	.0044	.0020	.0680	.0000	.0012
June 26, ...	.0000	.0010	.0128	.0060	.0188	.0056	.0030	.0800	.0000	.0006
July 12, ...	.0036	.0000	.0138	.0020	.0158	.0052	.0020	.0550	.0000	.0000
July 18, ...	.0046	.0002	.0178	.0042	.0220	.0058	.0050	.0650	.0002	.0001
July 24, ...	.0036	.0002	.0152	.0040	.0192	.0040	.0030	.0430	.0001	.0000
Average, . . .	.0017	.0011	.0108	.0123	.0231	.0052	.0068	.0573	.0002	.0003

The experiment was practically successful, as the water in the reservoir soon became a bright green, owing to the growth of immense numbers of the alga *Scenedesmus*, while the water in the gate-house apparently remained unchanged. The chemical and microscopical examinations showed, however, that the water in the gate-house had changed somewhat, which was probably due to leakage and the unsatisfactory character of the place for conducting an experiment of this kind. The results in the open reservoir are particularly instructive with regard to the changes which may take place in a ground water when it is exposed to the light. To exhibit these more clearly, the accompanying diagram has been prepared : —

Diagram showing the amounts of Dissolved and Suspended Albuminoid Ammonia and Nitrates in the Open Reservoir of the Hyde Park Water Co.; May 16 to July 24, 1889.



The history of the water in the reservoir appears to be as follows: The organisms, represented in the analysis by the suspended albuminoid ammonia, began to grow as soon as the water was turned into the reservoir, and when the first sample was taken, two days

after the filling of the reservoir was completed, they were present in great numbers. On May 29 the water contained the maximum amount of suspended organisms, which by their growth had used up practically all of the nitrogen in the inorganic form of nitrates originally contained in the water. From this time the number of organisms in the water decreased, probably by their sinking to the bottom and slopes of the reservoir. The albuminoid ammonia in solution, which in this case is either dissolved from or excreted by the organisms, showed a large increase from the beginning of the experiment to its end.

The microscopical examinations confirmed the results obtained by chemical analysis.

Taking the experiment as a whole, it is an excellent illustration of the rapidity with which organisms may develop in ground water containing suitable mineral food. Similar results have been obtained by Mr. F. F. Forbes,* from microscopical examinations of the water of the open distributing reservoirs at Brookline and Newton, subsequent to their being filled with fresh water.

It has sometimes been suggested that these growths in ground water reservoirs were due to insufficient circulation; that is, to not changing the water in the reservoir often enough. The foregoing experiment indicates that the algæ grow so rapidly when supplied with fresh water that it would be impracticable to change it often enough to prevent their growth. A practical experiment to test the value of such circulation was made at Brookline, and the results are stated by Mr. Forbes in the paper above alluded to, as follows: —

"As additional proof of the statement I have just made, I will relate a little experience we had in the Brookline reservoir several years ago. Everybody said that circulation was what we needed to keep the water free from algæ, and one time, after the reservoir had been carefully cleaned, this view of the case was given a thorough trial. It was in summer, when our daily consumption was about a million gallons. All the water, nearly, was pumped into one end of the reservoir, and made to pass through it. The amount of water in the reservoir during this trial was not much in excess of the daily consumption; in other words, nearly as much water was pumped into the reservoir each day, and drawn from it, as the

* "A Study of Algæ Growths in Reservoirs and Ponds," by F. F. Forbes, Superintendent of Water Works, Brookline, Mass. Journal of the New England Water Works Association, June, 1890.

reservoir contained, yet the algæ came in about the same length of time, and were fully as abundant. In consequence of this, the consumer received no water which was not laden with algæ; whereas, if the water had been pumped directly into the distribution, and only the surplus reached the reservoir, the water would have been good as long as pumping continued."

Summary.

In the foregoing comparisons and experiment, showing the effect of the storage of surface and ground waters in distributing reservoirs and tanks, we find that surface waters may be so stored without deteriorating in quality; and at one place (Lawrence) there is a marked improvement in the quality of the water, owing to the storage and subsequent passage through pipes to the consumers. The State does not contain any good examples of surface waters stored in covered reservoirs; but it seems probable that, under such conditions, water containing many algæ might become worse owing to their death when deprived of light.

With ground waters the case is entirely different, as the water at the source is free from organisms, and it only needs to be kept so in order to be delivered to the consumer in satisfactory condition. The comparisons show that the ground water does not deteriorate when the light is excluded;* but that it does when exposed to the light, except in some instances where the water is stored in iron tanks which receive only a limited amount of light. It seems hardly safe, however, in view of the unfavorable effect of storing ground water in the high-service tank at Brookline, to rely upon these apparent exceptions to the rule; and it is better in all cases to keep a ground water in the dark.

Storage of Surface Waters in Large Storage Reservoirs or Ponds.

As has been stated previously, it is almost always necessary, in order to obtain a surface water supply, to take the water which is stored in a natural pond, or, where such a source cannot be obtained, to build an artificial storage reservoir, to prevent a deficiency in the supply in dry seasons.

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* These statements are not true of imperfectly filtered surface waters, as they are frequently affected by a growth of *Crenothrix*, which thrives better in the dark than in the light.

The most obvious difference in these two kinds of storage is in the character of the basin. In a pond, unless the level has been changed, the existing conditions have prevailed so long that, even if the bottom is muddy, they may be expected to affect the water much less than vegetable deposits which have been flooded in reservoirs within a comparatively recent period. There are also other differences between ponds and reservoirs. The former are generally deeper and situated nearer the head waters of streams, so that they store the water for a much longer time. It is not uncommon for ponds to have a capacity equal to the yield of their watersheds for one, two or even three years. A pond having a small watershed, particularly if the region is gravelly or sandy, may receive nearly all of its water by filtration, and that which finds access to the pond from the surface will be free from contamination by swamps. A reservoir, on the contrary, is generally fed mainly by the stream upon which it is built, which in turn may derive a part of its supply from swamps.

It may therefore be said in a general way of natural ponds, as compared with storage reservoirs, that they are deeper, and receive more ground water and colorless surface water, and that the water in them is replaced less frequently; also that they do not contain in their bottoms recently flooded deposits of vegetable matter.

There are of course exceptions to these rules, as some ponds are very shallow, and others have been raised, thereby covering large areas of swamp and meadow; while, on the other hand, some artificial reservoirs have been prepared by removing all vegetable matter from them, so that in some respects they are better than ponds.

The storage of water in ponds and reservoirs has frequently favored the growth of algæ and other organisms which affect the taste and odor of water; but it has, on the other hand, been generally thought to decrease the color of the water by the bleaching action of the sun, and also to improve the water by sedimentation. The various effects of storage under different conditions, so far as they are indicated by the examinations made, will be given in detail.

The Effect of Storage upon Color.

Observations have been made of the color of water taken from the principal streams entering several reservoirs and ponds, and of the water at their outlets.

A direct comparison of the colors obtained at these two places shows not only the effect of storage, but also the effect of dilution by water, generally having less color, which enters the reservoir from the surrounding territory or from the ground. Where a very large proportion of the water enters the reservoir at the main inlet, the effect of dilution is of little account. In other cases it is much more important.

No special examinations have been made to ascertain the color of the water from these secondary sources; but, as it can be inferred from the nature of the surroundings, it is thought best in presenting the results to correct the color of the water at the inlet, so as to represent more accurately the average color of the whole of the water entering the reservoir. It is not claimed that this correction is an accurate one, but that it is better than none at all. In most of the cases the general result is the same whether the correction is applied or not.

The following table gives the average color of waters taken at the inlet and outlet of five reservoirs; also the percentage of the whole drainage area which is situated above the main inlet, and the capacity of the reservoir as compared with the amount of water flowing annually from the watershed: —

Table showing the Effect of Long Storage upon the Color of Water.

LOCALITY.	Percentage of Watershed above Inlet.	Average Time Required to fill the Reservoir. Months.	Color at Main Inlet.	Estimated Average Color of all Water entering Reservoir.	Color at Outlet.	Change.
Boston, Reservoir 3, . .	79	1.3	1.00	0.86	0.82	—.04
Boston, Reservoir 2, . .	97	0.4	1.10	1.07	0.98	—.09
Boston, Lake Cochituate, .	40	8.5	0.86	0.58	0.25	—.33
Boston, Reservoir 4, . .	84	7.5	1.40	1.27	0.72	—.55
Brockton Reservoir, . .	82	3.4	2.24	1.87	0.89	—.98

The above table shows in every case a decrease in the amount of color, which, however, is extremely small in Reservoirs 2 and 3. By referring to the third column, it will be seen that these reservoirs are very small in comparison with the amount of water entering them, so that on an average the water remains in them only about a month. In the dry season it may remain two or three months.

This length of time is thus shown to be too short to cause any marked change in the color of the water.

In Lake Cochituate and Reservoir 4, the average length of storage is eight months; and in these cases there is a very decided reduction of color, amounting to 57 per cent. in the lake and 43 per cent. in the reservoir. At Brockton the reduction in color is greater than in any other case, notwithstanding the fact that the average length of storage is somewhat less than one-half of that in the two cases last mentioned. This may be due to the fact that the observations at Brockton extended over only four months in the spring and summer, which is hardly a sufficient time for a fair comparison; or it may possibly be accounted for by the fact that this reservoir has much less depth than the others, so that it has a greater relative surface, and that it contains in summer more organisms which may assist in destroying the color. In addition to the cases recorded in the table, occasional observations have been made at the Ludlow Reservoir, Springfield, which give indications similar to the above. The average color of the feeders of this reservoir, as deduced from seven observations, is .61, while the average color of the water in the reservoir is .15.

Two excellent opportunities to determine the effect of storage upon color were afforded when the Parker Hill Distributing Reservoir of the Boston Water Works was temporarily shut off from the rest of the system, and no water passed into or out of it. It was first shut off Dec. 3, 1887, when the water in it had a color of 0.4. On April 2, 1888, the color was 0.35, or only a little lower than four months before; but on the eighteenth of June, 1888, the color had diminished to 0.1. The reservoir was next shut off Jan. 9, 1889. No direct observation of the color of the water was made at this time; but, from examinations of the source from which it is supplied, its color is known to have been 0.45. On June 4 of the same year, the color was only 0.05, and two months later the water was colorless.

In a large lake, during the summer when little water enters it, and a change in color cannot be attributed to dilution, a reduction of color occurs similar to that at the Parker Hill Reservoir. A good example of this is furnished by Lake Cochituate, as will be seen by the following table: —

Table showing Change in Color of Water in Lake Cochituate during the Summer Months.

	1887.	1888.	1889.	1890.
June 1,	0.30	0.35	0.15	0.20
July 1,	0.20	0.10	0.30	0.10
August 1,	0.30	0.10	0.10	0.03
September 1,	0.15	0.05	0.20	0.10
October 1,	0.10	0.05	0.30	0.05

In every year except 1889 there is a marked reduction in the color during the summer. The exception in this year appears to be due to the extremely high rainfall.

It is probably owing to this bleaching action, as well as to the infiltration of ground water, that lakes and ponds which are large in proportion to their watersheds have generally a low color.

The general conclusion reached from the above comparisons is that the color of water exposed to the sun in open reservoirs is reduced by storage; but that it must be stored for several months to cause any material reduction of color, and from six months to a year to remove practically all of it.

The Effect of Storage upon the Chemical Character of a Water.

Changes in the chemical character of a water, due to storage, may be observed in the same way as the change in color; that is, by the comparison of analyses of water taken at the main inlet and at the outlet of a pond or reservoir. The chemical determinations which have the greatest interest are the nitrogen compounds; namely, the free and albuminoid ammonia, and the nitrates and nitrites. The albuminoid ammonia is determined before and after filtration through filter paper, and the difference between these determinations represents the albuminoid ammonia from the suspended particles, which are for the most part algæ and other minute organisms. The following table shows comparative average analyses at four places: —

Table showing Effect of Long Storage upon the Nitrogen Compounds in Water.

[Parts per 100,000]

	Percentage of Watershed above Inlet.	Average Time required to fill Reservoir.	Free Ammonia.		Albuminoid Ammonia.				Nitrogen as			
					Dissolved.		Suspended.		Nitrates.		Nitrites.	
		Months.	Inlet.	Reservoir.	Inlet.	Reservoir.	Inlet.	Reservoir.	Inlet.	Reservoir.	Inlet.	Reservoir.
Boston, Reservoir 3,	79	1.3	.0042	.0041	.0272	.0230	.0030	.0047	.0255	.0197	.0004	.0003
Boston, Reservoir 2,	97	0.4	.0016	.0010	.0257	.0233	.0031	.0050	.0113	.0084	.0002	.0001
Boston, Reservoir 4,	84	7.5	.0017	.0013	.0278	.0204	.0030	.0032	.0077	.0079	.0001	.0001
Brockton Reservoir,	82	3.4	.0022	.0022	.0429	.0256	.0024	.0169	.0030	.0038	.0001	.0001
Average, . .	85	3.1	.0024	.0021	.0309	.0231	.0029	.0074	.0119	.0099	.0002	.0001

Before discussing the table, it is well to state that direct averages of monthly observations, as given above, may be misleading if the amount of any constituent varies much at different seasons of the year; because, in the average, equal weight is given to the high flow, which may in a month displace all of the water in a reservoir, and to the low flow, which may merely mix with that already in the reservoir without displacing much of it. In the present case, an examination of the monthly observations indicates that the results are not misleading except in the case of the dissolved albuminoid ammonia, which shows a greater reduction than should be ascribed to the effect of storage. This is the case particularly at Brockton, where the observations extended over only four months.

The table indicates that no significant changes take place in the amount of free ammonia and nitrites; but that there is a reduction of about one-sixth in the amount of nitrates, and a decided increase in the amount of suspended albuminoid ammonia. The last-named change corresponds to the well-known fact that organisms are more abundant in reservoirs than in streams.

Although the table indicates that in these instances the nitrogen compounds in stored waters do not undergo very radical changes, it is known that such changes do occur at some places. As instances, Jamaica Pond and the Ludlow Reservoir (which will be referred to subsequently) may be mentioned.

Storage in a large reservoir may have a salutary effect by mingling the different kinds of water which enter it; for instance, the bulk of the water in a reservoir may be that which has entered it

during the spring freshets when the water is in its purest state; and this water may dilute the much more swampy or polluted water which enters during a subsequent season of low flow, so that the bad quality of such water is much less noticeable than it would be if furnished directly to the water takers.

The Effect of Storage upon the Taste and Odor of Surface Waters.

This title is not intended to refer to the usual taste and odor of waters, but rather to those which at times make water very disagreeable. These troubles have in nearly all cases been traced to the growth of organisms in the water.

The existence of these troubles can best be determined from the practical experience of those using the water; but they are also indicated by the odors and the amount of suspended organic nitrogen as determined by the chemist, and by the abundance of microscopic growths as determined by the biologist.

Although streams are sometimes subject to certain disadvantages as sources of water supply, such as the pollution due to domestic and manufacturing wastes, the turbidity occasioned by rains, or the peaty character of the water caused by drainage from swamps, it is well known that they are not affected by the peculiar bad tastes and odors to which stored waters are subject. Practically the same conclusion is reached in the report of the biologist (page 603), who finds much smaller numbers of organisms in streams than in ponds and reservoirs.

These facts are of limited practical value, because water supplies cannot, in most cases, be obtained from streams without storage; and it is therefore desirable to indicate under what conditions of storage and with what character of water, troubles are least likely to occur; that is to say, are they less likely to occur in natural ponds or in artificial storage reservoirs, in deep basins or in shallow ones, in unpolluted or in polluted waters, in waters of high or of low color, or in those which are stored a long or a short time? In view of the necessarily imperfect record of the occurrence of bad tastes and odors, and the many causes which affect the results, it would be desirable to have observations at a much larger number of places than this State can furnish; but the observations which have been made throw considerable light upon the subject.

It has already been mentioned that streams are not subject to these bad tastes and odors. The same is true of nearly all of the

small reservoirs which contain but a few days' supply. These are frequently built upon mountain streams, and their most important office is to act as settling basins to catch the gravel, sand and débris brought down by the stream. The effect of reservoirs of this kind is wholly beneficial. In a great majority of cases, however, it is necessary to provide storage equal to the amount of water consumed in a month or more, and only such reservoirs as contain this amount of storage will be further considered.

Observations have been made on 71 ponds and reservoirs of this class, nearly all of which are sources of water supply. Of these, 45, or 63 per cent., have at some time given trouble from bad tastes and odors; but in three instances the troubles have occurred in reservoirs which have only recently been filled, and may not recur when the reservoirs are older. In 16 other cases the trouble has not been serious, or has occurred only at long intervals, leaving 26, or 37 per cent., of the ponds and older reservoirs which have given much trouble. In making a distinction between supplies which have given much and little trouble, those in which the aggregate duration of the bad tastes and odors has not exceeded one month in five years are included in the latter class.

In making a further classification it has been assumed that all natural ponds should be classed as ponds, even though they were made artificial in part by being raised; while all artificial reservoirs are classed as reservoirs, even though they may have existed as mill ponds for a very long time. Ponds and reservoirs are assumed to be polluted when the population upon the drainage area is more than 300 to the square mile, and the waste products from this population enter the pond or reservoir either directly or by filtration through the ground. In the latter case the sewage may be wholly purified by filtration, yet the effluent will contain nitrates which will promote the growth of organisms, and may thereby cause bad tastes and odors. Where the average depth is less than 9 feet, the pond or reservoir is called shallow; and in two instances where there is a great deal of very shallow flowage, ponds having an average depth of 10 feet are classed as shallow. Water having a color of 0.30 or more is assumed to have a high color.

Using the above arbitrary divisions, a classification of the ponds and reservoirs, with reference to the occurrence or non-occurrence of troubles, has been made. The three new reservoirs above referred to have been omitted; also Farm Pond and Chestnut Hill

Reservoir (both of which have once been seriously affected), for the reason that the former receives most of its water from the storage reservoirs on Sudbury River, and the latter was affected when it received water from Lake Cochituate only. The results are presented in the following table : —

A Classification of Ponds and Reservoirs with reference to Troubles from Bad Tastes and Odors.

CONDITION.	Ponds.			Reservoirs.		
	Much Trouble.	Little Trouble.	No Trouble.	Much Trouble.	Little Trouble.	No Trouble.
Polluted.						
Shallow and high color,	–	–	–	1	–	–
Shallow and low color,	–	–	–	–	–	–
Deep and high color,	1	–	–	–	1	–
Deep and low color,	3	4	–	–	–	–
Total polluted,	4	4	–	1	1	–
Unpolluted.						
Shallow and high color,	–	–	1	10	–	–
Shallow and low color,	3	1	–	1	–	2
Deep and high color,	–	2	2	1	2	4
Deep and low color,	1	4	16	3	2	1
Total unpolluted,	4	7	19	15	4	7
Total polluted and unpolluted,	8	11	19	16	5	7

The above table shows that, out of a total of 38 ponds, 8, or 21 per cent., have given much trouble from bad tastes and odors; while, of the 28 reservoirs, 16, or 57 per cent., are similarly affected.

In comparing the polluted and unpolluted ponds, the effect of pollution is very obvious. All of the polluted ponds are deep; but, notwithstanding this advantage, all are affected to some extent, and half of them give much trouble. Of the 25 deep unpolluted ponds, only 1 has given much trouble, 6 have given a little trouble, and 18 no trouble whatever. This indicates that there is little danger of having serious trouble from bad tastes and odors, if a water supply can be taken from a deep pond which is unpolluted. The shallow unpolluted ponds appear to be subject to bad tastes and odors, as 3 out of a total of 5 give much trouble, and 1 a little trouble.

Only 2 of the reservoirs are polluted, but these give the same indication as the 8 polluted ponds, 1 giving much trouble and the other a little. Of the 26 unpolluted reservoirs, one-half are shallow. Of these, 11 give much trouble and 2 give none. In nearly all of these cases in which trouble has occurred, the reservoirs have been constructed on new sites, and the soil and vegetable matter have not been removed from their bottoms and sides. In one of the cases where there is no trouble the reservoir was used to furnish power for a mill before being used as a source of domestic water supply. The conclusion to be drawn from this comparison is, that a shallow reservoir large enough to hold a supply for a month or more is quite sure to give trouble if the soil and vegetable matter are not removed from it before filling. The experience at the present time is too limited to enable us to predict what proportion of cleaned or old shallow reservoirs are likely to give trouble.

Of the 13 deep, unpolluted reservoirs, 4 give much trouble, 4 a little, and 5 none. It is noticeable that, of the 5 which give no trouble, 4 have had the soil and vegetable matter removed from them, and 1 was previously a storage reservoir for mill purposes; while, of the 8 which have given more or less trouble, none have been thoroughly cleaned, and only 1 was previously used for mill purposes; and even this has since been raised. Two of the older reservoirs, which are classed as giving little trouble, have not given any trouble in recent years.

Among the 4 deep reservoirs classed as giving much trouble is the Ludlow Reservoir, at Springfield, which has furnished bad water in summer for 16 years. The other 3 reservoirs of this class have not given nearly as much trouble.

In several instances the reservoirs which have given trouble are flowed over swamps and meadows.

Selecting from the table the high and low colored waters, we find that there are 24 of the former and 42 of the latter. Of those with a high color, 75 per cent. have given trouble; while of those with a low color but 52 per cent. are affected. This unfavorable showing for the high-colored waters appears to be due to other considerations than the color; that is to say, the high colors predominate in shallow reservoirs, while the low colors are found under the more favorable conditions of deep ponds. A study of the table in detail indicates that the effect of color, if any, is very much less than that of pollution and the conditions of storage.

The foregoing classification has been based for the most part upon the information obtained from official reports and other outside sources, and it may be instructive to compare the chemical characteristics of these waters, adhering to the same classification. Such comparisons are presented in the following tables : —

ANALYSES OF PONDS AND RESERVOIRS, FOLLOWING THE CLASSIFICATION IN THE TABLE ON PAGE 742.

*Polluted Ponds.**

[Parts per 100,000.]

CONDITION.	LOCATION.	Color.	Ammonia.			Nitrogen as		Total Nitrogen.	Excess of Chlorine.
			Free.	Albuminoid. Total.	Albuminoid. Sus-pended.	Nitrates.	Nitrites.		
Deep, and high color, — much trouble.	Woburn, Horn Pond,†	0.34	.0152	.0389	.0058	.0452	.0015	.1257	2.61
Deep, and low color, — much trouble.	Boston, Jamaica Pond,	0.03	.0157	.0398	.0299	.0160	.0004	.1072	0.33
	Boston, Mystic Lake,†	0.23	.0235	.0264	.0052	.0496	.0015	.1161	1.55
	Natick, Dug Pond,	0.15	.0050	.0218	.0039	.0238	.0004	.0658	0.44
	Average of four,	0.19	.0148	.0317	.0112	.0336	.0009	.1037	1.23
Deep, and low color, — little trouble.	Boston, Lake Cochituate,	0.25	.0026	.0207	.0039	.0148	.0003	.0529	.20
	Cambridge, Fresh Pond,	0.11	.0134	.0196	.0035	.0281	.0007	.0735	.94
	Haverhill, Lake Saltonstall,	0.05	.0015	.0145	–	.0050	.0003	.0304	.30
	Marlboro', Lake Williams,	0.06	.0006	.0196	.0043	.0053	.0001	.0400	.25
	Average,	0.12	.0045	.0186	.0039	.0133	.0004	.0492	.42
	Average of 8 polluted ponds,	0.15	.0097	.0252	.0081	.0235	.0007	.0764	.83

* The word polluted as used here has the definition given on page 741.

† A large part of the excess of chlorine is due to the drainage from tanneries.

Unpolluted Ponds.

CONDITION.	LOCATION.	Color.	Free.	Albuminoid. Total.	Albuminoid. Sus-pended.	Nitrates.	Nitrites.	Total Nitrogen.	Excess of Chlorine.
Shallow, and low color, — much trouble.	Malden, Spot Pond,	0.24	.0007	.0216	.0029	.0044	.0001	.0419	.06
	Nantucket, Wannacomet Pond,	0.07	.0002	.0163	–	.0034	.0002	.0307	.00
	Spencer, Shaw Pond,	0.03	.0007	.0136	–	.0059	–	.0289	.01
	Average,	0.11	.0005	.0172	.0029	.0046	.0001	.0338	.02
Shallow, and low color, — little trouble.	Haverhill, Lake Pentucket,	0.02	.0007	.0164	–	.0040	–	.0317	.09
Shallow, and high color, — no trouble.	Randolph, Great Pond,	0.76	.0008	.0253	.0026	.0043	.0001	.0479	.10
Deep, and low color, — much trouble.	Holyoke, Ashley and Wright ponds,	0.06	.0023	.0184	.0043	.0043	.0001	.0385	.02

ANALYSES OF PONDS AND RESERVOIRS, FOLLOWING THE CLASSIFICATION IN THE TABLE ON PAGE 742 — *Continued.*

Unpolluted Ponds — Concluded.

[Parts per 100,000.]

CONDITION.	LOCATION.	Color.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Sus-pended.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Total Nitrogen.	Excess of Chlorine.
Deep, and high color, — little trouble.	Danvers, Middleton Pond,	0.62	.0008	.0207	.0035	.0049	.0001	.0413	.01
	Westboro', Chauncy Pond,	0.56	.0005	.0320	.0103	.0025	.0001	.0600	.10
	Average, ...	0.59	.0006	.0263	.0069	.0037	.0001	.0506	.05
Deep, and low color, — little trouble.	Concord, Sandy Pond, .	0.03	.0001	.0129	–	.0041	.0001	.0256	.00
	Hingham, Accord Pond, .	0.23	.0003	.0144	.0017	.0043	.0001	.0292	.05
	Plymouth, Great and Little South ponds, . . .	0.00	.0003	.0130	–	.0013	.0000	.0230	.00
	Wakefield, Crystal Lake,	0.14	.0008	.0165	.0017	.0079	.0001	.0365	.14
	Average, ...	0.10	.0004	.0142	.0017	.0044	.0001	.0286	.05
Deep, and high color, — no trouble.	Lakeville, Assawompsett Pond, ...	0.38	.0003	.0209	–	.0023	–	.0371	.00
	Weymouth, Great Pond,	0.91	.0010	.0224	–	.0037	–	.0415	.07
	Average, ...	0.64	.0006	.0216	–	.0030	–	.0393	.03
Deep, and low color, — no trouble.	Abington, Big Sandy Pond,	0.15	.0008	.0160	–	.0063	.0001	.0335	.05
	Fall River, Watuppa Lake,	0.19	.0005	.0162	.0020	.0055	.0001	.0335	.02
	Gardner, Crystal Lake, .	0.02	.0013	.0111	–	.0050	.0001	.0245	.11
	Haverhill, Crystal Lake, .	0.13	.0009	.0166	–	.0030	–	.0310	.00
	Haverhill, Kenoza Lake, .	0.02	.0006	.0142	.0014	.0045	.0001	.0291	.04
	Hudson, Gates Pond, .	0.05	.0014	.0155	.0029	.0056	.0001	.0337	.02
	Lake Village, Lake Winnipiseogee, . . .	0.01	.0002	.0092	.0014	.0038	.0000	.0198	.02
	Montague, Lake Pleasant, .	0.01	.0021	.0081	.0013	.0064	.0000	.0220	.02
	New Bedford, Little Quittacas Pond, . . .	0.19	.0003	.0160	–	.0035	.0000	.0302	.02
	Norwood, Buckmaster Pond, ...	0.13	.0055	.0220	.0026	.0061	.0002	.0482	.04
	Peabody, Spring Pond, .	0.00	.0001	.0111	–	.0000	–	.0184	.00
	Peabody, Brown's Pond, .	0.17	.0001	.0169	–	.0013	–	.0293	.00
	Plymouth, Lout Pond, .	0.27	.0002	.0156	–	.0029	–	.0288	.00
	Salem, Wenham Lake, .	0.05	.0018	.0143	.0028	.0047	.0001	.0311	.09
	Sherborn, Waushakum Pond, ...	0.23	.0009	.0195	–	.0060	.0001	.0390	.06
	Webster, Lake Chaubunagungamaug, . . .	0.06	.0002	.0129	–	.0043	.0000	.0258	.01
	Average, ...	0.10	.0011	.0147	.0021	.0043	.0001	.0299	.03
	Average of 30 unpolluted ponds, ...	0.19	.0009	.0167	.0030	.0042	.0001	.0331	.04

Polluted Reservoirs.

CONDITION.	LOCATION.	Color.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Sus-pended.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Total Nitrogen.	Excess of Chlorine.
Shallow, and high color, — much trouble.	Arlington, Storage Reservoir,	0.73	.0024	.0475	.0165	.0246	.0002	.1118	.36
Deep, and high color, — little trouble.	Boston, Reservoir 3,* .	0.87	.0049	.0285	.0044	.0218	.0003	.0750	.19
	Average of 2 polluted reservoirs, . . .	0.80	.0036	.0380	.0104	.0232	.0002	.0934	.27

* Has not given trouble during the time covered by these examinations.

Analyses of Ponds and Reservoirs, following the Classification in the Table on Page 742 — *Continued.*

Unpolluted Reservoirs.

[Parts per 100,000.]

Condition.	Location.	Color.	Ammonia. Free.	Ammonia. Albuminoid. Total.	Ammonia. Albuminoid. Sus-pended.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Total Nitrogen.	Excess of Chlorine.
Shallow, and high color, — much trouble.	Athol, Phillipston Reservoir,	0.93	.0020	.0221	-	.0107	.0000	.0488	.03
	Brockton, Salisbury Brook Reservoir,	0.75	.0028	.0411	.0163	.0058	.0001	.0827	.01
	Easthampton, Williston Pond,	0.27	.0021	.0170	.0034	.0140	.0003	.0454	.13
	Hingham, Fulling Mill Pond,	0.36	.0028	.0282	.0131	.0068	.0002	.0612	.10
	Leominster, Haynes Reservoir,	0.39	.0023	.0409	.0133	.0067	.0001	.0816	-
	New Bedford, Acushnet Reservoir,*	1.36	.0015	.0248	.0018	.0150	.0001	.0579	.00
	Northborough, Storage Reservoir,	0.85	.0013	.0230	-	.0081	.0001	.0472	.02
	Wayland, Storage Reservoir,	0.83	.0020	.0298	.0040	.0108	.0001	.0633	-
	Westborough, Sandra Pond,†	0.45	.0026	.0244	-	.0079	.0001	.0504	.04
	West Springfield, Storage Reservoir,	0.31	.0009	.0133	-	.0057	.0001	.0284	.03
	Average,	0.65	.0020	.0265	.0086	.0091	.0001	.0567	.04
Shallow, and low color, — much trouble.	Chicopee, Dingle Brook Reservoir,	0.20	.0010	.0135	.0054	.0138	.0002	.0393	.06
Shallow, and low color, — no trouble.	Leominster, Morse Reservoir,	0.24	.0006	.0093	-	.0032	.0000	.0190	-
	Southbridge, Storage Reservoir,	0.25	.0014	.0181	.0045	.0045	.0001	.0374	.00
	Average,	0.24	.0010	.0137	.0045	.0038	.0000	.0282	.00
Deep, and high color, — much trouble.	Lynn, Birch Pond,	0.36	.0019	.0272	.0072	.0065	.0001	.0560	.00
Deep, and low color, — much trouble.	Fitchburg, Overlook Reservoir,	0.10	.0012	.0151	.0034	.0041	.0001	.0315	.02
	Springfield, Ludlow Reservoir,	0.15	.0019	.0381	.0154	.0039	.0002	.0748	.01
	Winchester, Storage Reservoir,	0.14	.0033	.0241	.0058	.0104	.0003	.0555	.13
	Average,	0.13	.0021	.0258	.0082	.0061	.0002	.0539	.05
Deep, and high color, — little trouble.	Gloucester, Dyke's Brook Reservoir,	0.52	.0069	.0229	.0037	.0044	.0002	.0496	-
	Lynn, Breed's Pond,	0.48	.0018	.0214	.0049	.0042	.0001	.0431	.00
	Average,	0.50	.0043	.0221	.0043	.0043	.0001	.0463	.00

* Has not given any trouble during the time covered by these examinations.

† Upper Pond, from which no water is now taken directly.

ANALYSES OF PONDS AND RESERVOIRS, FOLLOWING THE CLASSIFICATION IN THE TABLE ON PAGE 742 — *Concluded.*

Unpolluted Reservoirs — Concluded.

[Parts per 100,000.]

CONDITION.	LOCATION.	Color.	Ammonia.			Nitrogen as		Total Nitrogen.	Excess of Chlorine.
			Free.	Albuminoid. Total.	Albuminoid. Sus-pended.	Nitrates.	Nitrites.		
Deep, and low color, — little trouble.	Greenfield, Glen Brook Reservoir,* . . .	0.03	.0010	.0046	–	.0090	.0001	.0175	.03
	Worcester, Leicester Reservoir,†	0.25	.0040	.0162	.0021	.0062	.0001	.0372	.01
	Average, ...	0.14	.0025	.0104	.0021	.0076	.0001	.0273	.02
Deep, and high color, — no trouble.	Boston, Reservoir 4, . .	0.73	.0006	.0260	.0042	.0056	.0001	.0509	.03
	Boston, Reservoir 2, . .	1.01	.0008	.0296	.0053	.0089	.0002	.0608	.10
	Cambridge, Stony Brook Reservoir, . . .	0.73	.0033	.0286	.0048	.0151	.0002	.0672	.09
	Westfield, Storage Reservoir, ...	0.54	.0003	.0147	–	.0044	.0001	.0290	.00
	Average, ...	0.75	.0012	.0247	.0048	.0085	.0001	.0520	.05
Deep, and low color, — no trouble.	Worcester, Holden Reservoir,	0.19	.0009	.0155	.0042	.0038	.0001	.0319	–
	Average of 26 unpolluted reservoirs, . . .	0.48	.0020	.0227	.0065	.0077	.0001	.0488	.03

* The trouble in this reservoir has been attributed to mud and leaves washed in by the mountain stream which feeds it.

† Has not given trouble during the time covered by these examinations.

In making comparisons between the different waters given in this table, it should be borne in mind that the amount of pollution is best indicated by the excess of chlorine.

A comparison of the analyses of the first four polluted ponds which give much trouble with the next four which give little, shows that the quantity of each of the constituents in the former is in every case larger than in the latter. As this is mainly the effect of pollution, it emphasizes the conclusion before reached, that pollution is one of the prominent factors in producing bad tastes and odors.

It will also be seen upon examination that the suspended albuminoid ammonia, which represents approximately the quantity of algæ and other organisms in the water, is most frequently found in waters which are subject to bad tastes and odors. This is shown in a general way by the following condensed table : —

	Suspended Albuminoid Ammonia.		
	Much Trouble.	Little Trouble.	No Trouble.
Polluted ponds,	.0112	.0039	-
Polluted reservoirs,	.0165	.0044	-
Unpolluted ponds,	.0036	.0043	.0021
Unpolluted reservoirs,	.0081	.0036	.0046

Having shown the conditions under which bad tastes and odors are most prevalent, it may be asked why this is so. The answer to this question must necessarily be a complicated one, and must, with our present knowledge, involve much uncertainty; but the indications point to the supply of nitrogenous food for animal and vegetable organisms as being one of the most important factors.

The principal sources from which the nitrogenous compounds in water are obtained are the rainfall, swamps and other deposits of decaying vegetable matter, manured fields, and domestic and manufacturing sewage. The nitrogen derived from the rainfall is insufficient in quantity to support any very large growth of organisms. It is, therefore, mainly from other sources that the nitrogen must come to produce the abnormal growths which cause serious trouble. In the case of polluted ponds the supply comes mainly from sewage, and from animal manures which are produced or used in populous districts. It may be well to state here, even at the risk of repetition, that, even if sewage is turned into a cesspool and filters a very long distance before reaching a pond, and in its passage through the ground has all of the organic matter in it destroyed, it will still contain in an inorganic form a large part of the nitrogen, and may have nearly the same effect in promoting growths of organisms in a pond as if the sewage was turned into it directly. The source from which uncleaned reservoirs may obtain a large part of their nitrogen is the vegetable matter at the bottom. A good instance of this is furnished at the Ludlow Reservoir, Springfield. The amount of nitrogen in the reservoir water in summer, when the growth of algæ is at its height, is three times as great as in the winter; and, since the amount contained in the water entering the reservoir through its feeders is not large, the only source from which it seems possible to obtain this additional nitrogen is the reservoir bottom. With

regard to the depth and size, and absence of very shallow flowage, this reservoir ranks high among those in the State.

As a further indication that depth is less important than the food supply, the case of Pilling's Pond in Lynnfield may be cited. This is a very old storage reservoir, made for mill purposes by flowing a large level meadow to a depth of four feet. The average depth of the pond, including the shallow portions near the edges, is about three feet. At the time of the examination it was kept constantly full. The area of the pond is in the neighborhood of eighty-five acres. Examinations made during the summer of 1889 showed that, notwithstanding the small depth and the consequent high temperature of the water which at times reached eighty degrees, Fahrenheit, the water, did not contain any abnormal growth of organisms, or become offensive. This comparatively favorable result appears to be due to the fact that the reservoir is so old that the available food has been removed from the mud at the bottom.

To avoid giving the impression that bad tastes and odors are caused only by an abundance of nitrogenous organisms, it is well to cite the case of Naukeag Pond in Ashburnham, which had a very disagreeable odor when it was examined in the spring of 1888 and again in 1889. This pond is deep and unpolluted, and did not contain an unusual amount either of organisms or of nitrogen. Cases of this kind are, however, exceptions to the general rule.

The most important conclusions to be reached from this study of bad tastes and odors are, that from this stand-point a water supply should not be chosen which receives much sewage, either directly or after purification; and that, if water is to be stored in a new artificial storage reservoir, it should have the vegetable matter removed from its bottom and sides.

SPECIAL INVESTIGATION OF DEEP PONDS.

The effect of the storage of water in shallow ponds and reservoirs in producing bad tastes and odors has already been discussed. This section will be confined to a consideration of the character of water in deep ponds at different depths, and the changes which occur at different seasons of the year, owing to the circulation or stagnation of the water, caused mainly by the difference in temperature of the various layers. As already stated, investi-

gations of this subject have been made, chiefly at Jamaica Pond, other ponds being examined only to a limited extent for purposes of comparison. Upon pp. 665 and 666 of this volume will be found a plan of this pond, and a diagram showing the temperatures at different depths; also, in connection with these, a discussion of the vertical currents caused by changes of temperature. The main facts established are that vertical circulation takes place until about the first of April, after which the surface water becomes warmed, and consequently does not mingle with that at the bottom until some time in November, when the surface water again becomes cold enough to sink. During the seven months from April to November the bottom water is stagnant and does not come into contact with the air; and, if it contains much matter capable of undergoing decomposition, the dissolved oxygen is soon used up, and the water becomes very foul.

Jamaica Pond was chosen for special investigation because it contained, two months before, an enormous growth of *Oscillaria*, and it was thought that it would consequently contain much decomposing matter at the bottom, and therefore present extreme conditions.

Samples of water for chemical and microscopical examinations were collected from the pond at six depths; namely, at the surface, and ten, twenty, thirty, forty, and fifty feet below, the deepest sample being taken near the bottom of the pond. In some instances, when the surface of the pond was below high-water mark, it has been impracticable to get a sample quite as deep as fifty feet; but, for convenience, the sample taken as near this depth as practicable has always been designated as the fifty-foot sample. The samples were taken frequently, and the analyses if printed in full would occupy much space. They are, therefore, presented in a somewhat condensed form in two tables. The first, given on the next two pages, contains five complete series of analyses, representing typical conditions at different seasons of the year. The other, given on pp. 756–759, contains all of the determinations of the nitrogen in its different forms, together with an average which is intended to be representative of the whole mass of water contained in the pond; that is, not a direct average of the figures obtained by analyzing the water at the different depths, but one in which the analyses at each depth are given weight in proportion to the amount of water which they represent. In addition to these, the last three columns show respectively the organic nitrogen, as deduced from the

albuminoid ammonia by methods already indicated in the report of the chemist (pp. 545 and 549); the inorganic nitrogen, including under this head the nitrogen in the free ammonia and in the nitrates and nitrites; and the total nitrogen, which is the sum of the organic and inorganic.

Table of Analyses of Jamaica Pond Water, showing Typical Conditions at Different Seasons of the Year.

Samples collected April 4, 1890, when circulation, which had been more or less active for five months, was about to cease.

[Parts per 100,000.]

Number.	Depth below Surface — Feet.	Temperature — Degrees Fahr.	Appearance.			Odor.		Ammonia.			Nitrogen as		Total Nitrogen.
			Turbidity.	Sediment.	Color.	Cold.	Hot.	Free.	Albuminoid. Dis-solved.	Albuminoid. Sus-pended	Nitrates.	Nitrites.	
5845	0	48.2	Distinct.	Considerable, white.	0.00	Distinctly vegetable.	Distinctly vegetable.	.0006	.0200	.0176	.0350	.0010	.1058
5846	10	40.9	Distinct.	Considerable, white.	0.00	Distinctly vegetable.	Distinctly vegetable.	.0004	.0178	.0192	.0420	.0012	.1145
5847	20	40.9	Distinct.	Considerable, white.	0.00	Distinctly vegetable.	Decidedly vegetable.	.0010	.0204	.0142	.0400	.0010	.1048
5848	30	40.8	Distinct.	Considerable, white.	0.00	Distinctly vegetable.	Distinctly vegetable.	.0012	.0200	.0164	.0520	.0010	.1208
5849	40	40.8	Distinct.	Considerable, white.	0.00	Faintly vegetable.	Distinctly vegetable.	.0014	.0188	.0156	.0540	.0010	.1193
5850	50	40.8	Distinct.	Considerable, white.	0.00	Faintly vegetable.	Distinctly vegetable.	.0008	.0180	.0160	.0480	.0012	.1126

Samples collected April 29, 1890, after circulation had ceased, and free ammonia had begun to accumulate at the bottom.

Number.	Depth below Surface — Feet.	Temperature — Degrees Fahr.	Turbidity.	Sediment.	Color.	Cold.	Hot.	Free.	Dis-solved.	Sus-pended	Nitrates.	Nitrites.	Total Nitrogen.
5917	0	52.9	Slight.	Considerable, green.	0.00	Distinctly vegetable.	Faintly vegetable.	.0000	.0172	.0082	.0600	.0010	.1063
5918	10	52.9	Slight.	Considerable, green.	0.00	Distinctly vegetable.	Faintly vegetable.	.0000	.0164	.0140	.0480	.0009	.1047
5919	20	48.9	Slight.	Considerable, green.	0.00	Very faint or none.	Distinctly vegetable.	.0016	.0166	.0166	.0550	.0009	.1188
5920	30	45.3	Slight.	Slight.	0.00	Very faint or none.	Faintly vegetable.	.0060	.0162	.0094	.0430	.0009	.0949
5921	40	44.6	Very slight.	Considerable, white.	0.00	Faintly disagreeable.	Faintly vegetable.	.0128	.0160	.0138	.0620	.0012	.1285
5922	50	43.9	Distinct.	Heavy, flocculent.	0.05	Faintly disagreeable.	V'y faintly disagreeable.	.0800	.0190	.0168	.0280	.0015	.1613

Table of Analyses of Jamaica Pond Water, etc. — *Concluded.*

Samples collected Aug. 14, 1890, during the period of stagnation, when much free ammonia had accumulated at the bottom.

[Parts per 100,000.]

Number.	Depth below Surface — Feet.	Temperature — Degrees Fahr.	Appearance. Turbidity.	Appearance. Sediment.	Appearance. Color.	Odor. Cold.	Odor. Hot.	Ammonia. Free.	Ammonia. Albuminoid. Dis-solved.	Ammonia. Albuminoid. Sus-pended.	Nitrogen as Nitrates.	Nitrogen as Nitrites.	Total Nitrogen.
6401	0	73.9	Distinct, white.	Slight.	0.00	Faintly vegetable.	Pungent.	.0000	.0220	.0142	.0030	.0000	.0685
6402	10	73.9	Distinct, white.	Slight.	0.00	Very faint or none.	Pungent.	.0002	.0240	.0164	.0050	.0000	.0786
6403	20	55.6	Slight.	Slight, green.	0.00	Distinctly vegetable.	V'y faintly vegetable.	.0080	.0176	.0170	.0400	.0002	.1108
6404	30	46.6	Slight.	Slight, green.	0.00	Faintly vegetable.	None.	.0328	.0164	.0062	.0300	.0044	.1010
6405	40	44.4	Distinct.	Slight.	0.00	Disagree-able.	Disagree-able.	.1680	.0230	.0080	.0089	.0001	.2008
6406	50	44.2	Slight, milky.	Slight.	0.00	Offensive.	Disagree-able.	.4720	.0350	.0110	.0150	.0000	.4839

Samples collected Nov. 13, 1889, when the cooling of the water had caused vertical circulation to a depth of thirty feet, thereby increasing the free ammonia in the upper layers, and making the water of uniform quality to this depth.

Number.	Depth below Surface — Feet.	Temperature — Degrees Fahr.	Turbidity.	Sediment.	Color.	Cold.	Hot.	Free.	Dis-solved.	Sus-pended.	Nitrates.	Nitrites.	Total Nitrogen.
5338	0	48.6	Slight.	Very slight.	0.03	Very faint or none.	Faintly vegetable.	.0206	.0162	.0048	.0120	.0003	.0659
5339	10	48.2	Slight.	Slight.	0.10	V'y faintly vegetable.	Faintly vegetable.	.0208	.0164	.0060	.0100	.0002	.0668
5340	20	47.8	Slight.	Very slight.	0.03	Faintly disagree-able.	Very faint or none.	.0194	.0164	.0072	.0090	.0002	.0671
5341	30	47.5	Very slight.	Slight.	0.05	Distinctly disagree-able.	Very faint or none.	.0200	.0176	.0066	.0110	.0002	.0703
5342	40	43.3	Slight, milky.	Sli't, light brown.	0.40	Offensive.	Offensive.	.3320	.0330	.0130	.0050	.0001	.3595
5343	50	42.8	Distinct, milky.	Sli't, light brown.	0.50	Offensive.	Offensive.	.4840	.0410	.0090	.0090	.0000	.4935

Samples collected Nov. 27, 1889, after vertical circulation had been established to the bottom, and the water was consequently of uniform quality throughout the pond.

Number.	Depth below Surface — Feet.	Temperature — Degrees Fahr.	Turbidity.	Sediment.	Color.	Cold.	Hot.	Free.	Dis-solved.	Sus-pended.	Nitrates.	Nitrites.	Total Nitrogen.
5384	0	44.8	Very slight.	Slight.	0.00	Distinctly disagree-able.	Distinctly disagree-able.	.0640	.0180	.0066	.0120	.0009	.1089
5385	10	44.8	Very slight.	Slight.	0.00	Distinctly disagree-able.	Distinctly disagree-able.	.0520	.0202	.0112	.0120	.0008	.1120
5386	20	44.8	Very slight.	Consider-able.	0.05	Distinctly disagree-able.	Distinctly disagree-able.	.0672	.0184	.0072	.0120	.0007	.1132
5387	30	44.8	Slight.	Slight.	0.05	Distinctly disagree-able.	Distinctly disagree-able.	.0624	.0184	.0056	.0180	.0007	.1120
5388	40	44.8	Slight.	Consider-able.	0.00	Faintly disagree-able.	Distinctly disagree-able.	.0704	.0184	.0042	.0150	.0008	.1128
5389	50	44.8	Slight.	Slight.	0.00	Faintly disagree-able.	Distinctly disagree-able.	.0712	.0174	.0062	.0150	.0009	.1160

The prominent changes in the character of the water, as indicated by the foregoing table, will be first referred to. The observations of April 4, 1890, were made after a mild winter, during which the pond had been covered with ice but little of the time, and circulation of the water to the bottom was probably produced frequently by the wind. A few days before these observations were made, active circulation was known to have been caused by changes of temperature, because the surface water was then being warmed to the temperature of maximum density. As a result of this circulation, the water was uniform in quality from the bottom to the surface, and the products of decay, which existed in the water in large quantities the previous autumn, had disappeared by oxidation or had been absorbed by organisms which were particularly abundant at this time.

Immediately after this date the free ammonia began to accumulate in the bottom layers, and on April 29, 1890, the date of the second set of observations given in the table, was present in considerable quantity. In the latter part of the summer the difference between the surface and bottom water became most marked. The water at the surface, containing no free ammonia, was in as good condition as at any season of the year, while that at the bottom was foul, and loaded with the products of decay. A sample from the bottom at this time, when first collected had little or no color, but after standing became a deep, yellow-brown. The odor of the bottom water at this season of the year was generally very offensive, and often that of sulphuretted hydrogen. This condition of the water is indicated by the analyses of Aug. 14, 1890.

Water of this character while at the bottom of the pond cannot undergo any improvement, on account of the absence of free oxygen, and it consequently remains in a foul condition, to rise in the autumn (when circulation is established between the surface and the bottom) and mingle with the whole mass of water, affecting injuriously that nearer the surface. The effect of the circulation will be seen by reference to the series of Nov. 27, 1889, when the odor of the water was distinctly disagreeable at all depths, and the free ammonia at the surface had increased from practically nothing in the summer to .0640 parts per 100,000.

From the foregoing description it will be seen that there are two prominent differences between the storage of water in a deep pond like the one here described and a shallower one in which the water

is overturned to the bottom by every strong wind. In the deep pond the surface and bottom layers are entirely distinct during the summer, and practically no water passes from one to the other, though there may be a passage of organisms or gases; as, for instance, when dead algæ or animals sink from the surface layers to lower ones or to the bottom, or when gases produced by decomposition at the bottom rise to the surface. The changes consequent upon the growth and death of the organisms diminish the amount of nitrogen in the upper layers of the water during the summer, and thereby improve its quality.

In a shallow pond, on the contrary, the nitrogenous products resulting from the decay of the organisms which drop to the bottom, or of any organic matter in the material of which the bottom is composed, are frequently brought to the surface, where they may promote a new growth of organisms. In view of these differences, it may be questioned whether any very abundant growth of organisms, such as occurs in the Ludlow Reservoir at Springfield, is likely to take place *during the summer* in a deep pond. In the autumn the accumulated products in the bottom of a deep pond are mingled with the upper layers, from which water is usually drawn for use; and at this time the shallower pond, which, by reason of the frequent circulation of its waters, is of uniform quality at all depths, may have an advantage over the deep one.

General experience seems to indicate that depth is on the whole an advantage; but, in view of the above facts, it may be questioned whether, under some circumstances, it is not a disadvantage to have a depth in excess of that to which the water will circulate at all seasons of the year.

In addition to the more practical results of this investigation, which have already been fully stated, the changes in the amount of nitrogen in the pond, and the form and place in which it appears at different seasons of the year, are of interest. These features are shown in the table on pages 756–759 and by the diagram on page 760.

It may be said, first, that the total nitrogen in the whole mass of water in the pond, as given in the last column of the table above mentioned, does not vary very much throughout the year, and this feature is no less marked when the different nitrogen compounds are undergoing rapid changes than at other times. A good example is furnished by the following comparison of the results obtained on

Nov. 27, 1889, when a large part of the nitrogen was contained in the free ammonia, and on March 26, 1890, when none was in this form : —

[Parts per 100,000.]

	Nov. 27, 1889.	Mar. 26, 1890.
Nitrogen as free ammonia,	.0509	.0000
Nitrogen as dissolved albuminoid ammonia,	.0310	.0246
Nitrogen as suspended albuminoid ammonia,	.0156	.0383
Nitrogen as nitrates,	.0136	.0436
Nitrogen as nitrites,	.0008	.0013
Total,	.1119	.1078

It has sometimes been thought that the disappearance of free ammonia from water, under conditions like these, was due largely to its escaping into the air as ammonia gas ; but the above comparison indicates that nearly all, if not all, reappears in other forms.

If, instead of considering the nitrogen in the whole contents of the pond, we take the different depths separately, the quantities found in the surface and bottom layers are not constant throughout the year. In April and November, when vertical circulation is active, the nitrogen, as well as all other constituents, is found in the same quantity at all depths ; but, during the summer stagnation, the appropriation of nitrogen in the upper layers by organisms which drop into the lower layers or to the bottom decreases the amount of nitrogen near the surface, and increases it near the bottom. The amount of nitrogen thus transferred is well indicated by a single series of analyses, made Aug. 14, 1890, as follows : —

Depth in feet.	Total Nitrogen in parts per 100,000.
0,	.0685
10,	.0786
20,	.1108
30,	.1010
40,	.2008
50,	.4839
Average for the whole pond,	.1069

At this time the last two samples, which represent 12.5 per cent. of the water in the pond, contained 26 per cent. of the whole amount of nitrogen. This accumulation at the bottom suggests the possibility of improving the quality of a body of water by drawing from its lower layers and wasting, during August and September, the water which contains the accumulated nitrogen.

Table of Analyses of Jamaica Pond water at six depths.

NOTE.—The averages given below are not a direct mean of the analyses at the different depths, but are obtained by giving each depth weight in proportion to the amount of water represented.

[Parts per 100,000.]

	DATE.	FREE AMMONIA.						
		0	10	20	30	40	50	Average.
	1889.							
1	July 25,	.0000	.0000	.0000	.0096	.2040	.3880	.0294
2	Aug. 22,	.0006	.0005	.0160	.0488	.3100	.4000	.0533
3	Oct. 23,	.0068	.0068	.0064	.0920	.4200	.5920	.0773
4	Oct. 30,	.0088	.0074	.0094	.0920	.5600	.7680	.0963
5	Nov. 6,	.0102	.0114	.0108	.0128	.2400	.7280	.0453
6	Nov. 13,	.0206	.0208	.0194	.0200	.3320	.4840	.0608
7	Nov. 20,	.0552	.0568	.0560	.0760	.2000	.3720	.0799
8	Nov. 27,	.0640	.0520	.0672	.0624	.0704	.0712	.0619
9	Dec. 4,	.0560	.0608	.0624	.0632	.0624	.0640	.0610
10	Dec. 18,	.0640	.0600	.0496	.0504	.0480	.0488	.0549
11	Dec. 26,	.0448	.0400	.0440	.0432	.0432	.0464	.0428
	1890.							
12	Jan. 1,	.0384	.0360	.0416	.0368	.0376	.0384	.0380
13	Jan. 8,	.0288	.0296	.0280	.0280	.0280	.0288	.0286
14	Jan. 16,	.0240	.0248	.0272	.0256	.0248	.0256	.0254
15	Feb. 17,	.0106	0100	.0100	.0102	.0106	.0118	.0102
16	March 18,	.0012	.0011	.0010	.0020	.0015	.0010	.0013
17	March 26,	.0000	.0000	.0000	.0000	.0002	.0004	.0000
18	April 4,	.0006	.0004	.0010	.0012	.0014	.0008	.0009
19	April 10,	.0024	.0030	.0032	.0028	.0028	.0030	.0029
20	April 17,	.0044	.0040	.0044	.0042	.0036	.0048	.0042
21	April 29,	.0000	.0000	.0016	.0060	.0128	.0800	.0039
22	May 8,	.0000	.0000	.0062	.0064	.0224	.0736	.0060
23	May 15,	.0060	.0062	.0056	.0072	.0184	.1184	.0089
24	May 22,	.0000	.0002	.0014	.0050	.0240	.1192	.0054
25	May 29,	.0050	.0046	.0066	.0016	.0296	.2200	.0098
26	June 5,	.0034	.0034	.0108	.0044	.0304	.2040	.0106
27	June 12,	.0038	.0046	.0168	.0134	.0452	.1800	.0154
28	June 19,	.0012	.0006	.0260	.0168	.0640	.1720	.0188
29	July 7,	.0002	.0006	.0192	.0288	.0936	.2280	.0235
30	July 18,	.0004	.0006	.0206	.0278	.1600	.4480	.0336
31	July 31,	.0002	.0000	.0134	.0350	.1490	.6870	.0344
32	Aug. 14,	.0000	.0002	.0080	.0328	.1680	.4720	.0328
33	Aug. 28,	.0026	.0028	.0114	.0464	.1800	.4120	.0381
34	Sept. 11,	.0010	.0010	.0050	.0720	.1800	.4440	.0414
35	Sept. 22,	.0016	.0022	.0138	.0642	.2360	.5320	.0496
36	Oct. 1,	.0042	.0042	.0076	.0680	.2000	.5000	.0455
37	Oct. 9,	.0052	.0058	.0076	.0760	.2480	.4200	.0522
38	Oct. 16,	.0034	.0038	.0026	.0936	.3520	.4520	.0657
39	Oct. 24,	.0162	.0148	.0150	.0480	.3600	.4800	.0664
40	Oct. 30,	.0304	.0296	.0304	.0304	.3040	.5920	.0675
41	Nov. 6,	.0472	.0464	.0472	.0456	.0456	.5600	.0522
42	Nov. 13,	.0592	.0600	.0600	.0608	.0600	.1600	.0611
43	Nov. 20,	.0608	.0608	.0624	.0624	.0600	.0640	.0614
44	Dec. 2,	.0600	.0600	.0624	.0600	.0600	.0600	.0605

Table of Analyses of Jamaica Pond water at six depths — Continued.

NOTE. — The averages given below are not a direct mean of the analyses at the different depths, but are obtained by giving each depth weight in proportion to the amount of water represented.

[Parts per 100,000.]

Dissolved Albuminoid Ammonia.							Suspended Albuminoid Ammonia.							
0	10	20	30	40	50	Average.	0	10	20	30	40	50	Average.	
.0226	.0187	.0144	.0142	.0206	.0228	.0178	.0080	.0248	.0433	.0188	.0529	.0802	.0287	1
.0202	.0230	.0218	.0162	.0257	.0296	.0213	.0106	.0195	.0242	.0248	.0358	.0344	.0220	2
.0180	.0164	.0176	.0220	.0290	.0450	.0198	.0060	.0082	.0086	.0130	.0400	.0410	.0129	3
.0220	.0204	.0176	.0260	.0420	.0510	.0240	.0060	.0088	.0040	.0090	.0240	.0200	.0091	4
.0184	.0166	.0170	.0164	.0210	.0350	.0177	.0056	.0064	.0048	.0060	.0120	.0140	.0065	5
.0162	.0164	.0164	.0176	.0330	.0410	.0188	.0048	.0060	.0072	.0066	.0130	.0090	.0070	6
.0238	.0204	.0194	.0190	.0200	.0260	.0205	.0076	.0100	.0082	.0060	.0170	.0180	.0092	7
.0180	.0202	.0184	.0184	.0184	.0174	.0188	.0066	.0112	.0072	.0056	.0042	.0062	.0076	8
.0186	.0174	.0192	.0202	.0202	.0198	.0188	.0054	.0064	.0042	.0048	.0062	.0060	.0055	9
.0186	.0196	.0182	.0192	.0176	.0174	.0188	.0096	.0096	.0070	.0062	.0092	.0088	.0082	10
.0214	.0204	.0202	.0212	.0180	.0182	.0204	.0094	.0114	.0156	.0086	.0100	.0088	.0112	11
.0226	.0260	.0232	.0218	.0203	.0188	.0230	.0158	.0112	.0094	.0082	.0083	.0084	.0108	12
.0168	.0144	.0152	.0166	.0158	.0150	.0156	.0158	.0160	.0124	.0158	.0124	.0100	.0146	13
.0184	.0186	.0172	.0170	.0162	.0174	.0176	.0098	.0126	.0130	.0126	.0130	.0132	.0123	14
.0208	.0158	.0172	.0170	.0176	.0166	.0173	.0190	.0202	.0116	.0130	.0122	.0130	.0157	15
.0194	.0175	.0156	.0166	.0179	.0192	.0173	.0136	.0144	.0152	.0144	.0152	.0160	.0145	16
.0152	.0156	.0160	.0134	.0132	.0136	.0149	.0234	.0190	.0146	.0178	.0202	.0198	.0186	17
.0200	.0178	.0204	.0200	.0188	.0180	.0194	.0176	.0192	.0142	.0164	.0156	.0160	.0167	18
.0192	.0174	.0180	.0208	.0174	.0182	.0185	.0142	.0152	.0140	.0148	.0150	.0142	.0147	19
.0178	.0182	.0172	.0174	.0164	.0148	.0175	.0128	.0128	.0142	.0138	.0122	.0170	.0133	20
.0172	.0164	.0166	.0162	.0160	.0190	.0165	.0082	.0140	.0166	.0094	.0138	.0168	.0127	21
.0184	.0188	.0170	.0172	.0152	.0174	.0176	.0078	.0136	.0090	.0044	.0056	.0100	.0088	22
.0158	.0162	.0170	.0172	.0174	.0178	.0167	.0042	.0040	.0062	.0070	.0120	.0248	.0062	23
.0154	.0160	.0168	.0172	.0182	.0196	.0166	.0096	.0072	.0194	.0054	.0034	.0156	.0098	24
.0178	.0166	.0160	.0170	.0174	.0260	.0169	.0036	.0038	.0084	.0142	.0060	.0250	.0074	25
.0150	.0154	.0176	.0176	.0184	.0380	.0169	.0062	.0044	.0060	.0120	.0092	.0120	.0092	26
.0172	.0174	.0184	.0176	.0162	.0360	.0177	.0030	.0048	.0066	.0078	.0100	.0060	.0061	27
.0184	.0174	.0162	.0152	.0180	.0300	.0171	.0046	.0030	.0034	.0064	.0002	.0130	.0038	28
.0196	.0214	.0196	.0178	.0180	.0230	.0196	.0084	.0082	.0108	.0080	.0096	.0220	.0091	29
.0194	.0178	.0172	.0132	.0190	.0200	.0172	.0160	.0140	.0106	.0104	.0090	.0260	.0124	30
.0166	.0206	.0188	.0160	.0230	.0310	.0190	.0238	.0090	.0096	.0082	.0120	.0140	.0119	31
.0220	.0240	.0176	.0164	.0230	.0350	.0207	.0142	.0164	.0170	.0062	.0080	.0110	.0131	32
.0234	.0216	.0158	.0140	.0240	.0270	.0194	.0074	.0074	.0082	.0058	.0050	.0120	.0070	33
.0192	.0204	.0180	.0150	.0270	.0280	.0194	.0234	.0218	.0070	.0040	.0050	.0140	.0132	34
.0224	.0238	.0156	.0154	.0180	.0210	.0193	.0176	.0202	.0060	.0080	.0130	.0170	.0133	35
.0230	.0206	.0236	.0158	.0310	.0270	.0220	.0118	.0124	.0088	.0086	.0050	.0090	.0098	36
.0202	.0190	.0196	.0174	.0170	.0310	.0187	.0104	.0114	.0082	.0052	.0140	.0300	.0100	37
.0194	.0198	.0196	.0168	.0160	.0430	.0189	.0102	.0110	.0110	.0038	.0190	.0250	.0105	38
.0176	.0186	.0182	.0236	.0120	.0190	.0186	.0114	.0096	.0088	.0038	.0130	.0120	.0090	39
.0172	.0170	.0168	.0154	.0150	.0190	.0165	.0108	.0102	.0108	.0138	.0050	.0150	.0106	40
.0210	.0192	.0196	.0188	.0182	.0220	.0194	.0122	.0118	.0098	.0108	.0104	.0100	.0111	41
.0210	.0190	.0194	.0206	.0210	.0218	.0200	.0132	.0164	.0112	.0074	.0074	.0170	.0119	42
.0230	.0204	.0192	.0204	.0212	.0226	.0206	.0076	.0094	.0080	.0036	.0040	.0038	.0069	43
.0232	.0224	.0212	.0214	.0236	.0244	.0222	.0046	.0032	.0052	.0062	.0080	.0038	.0050	44

Table of Analyses of Jamaica Pond water at six depths — Continued.

NOTE.—The averages given below are not a direct mean of the analyses at the different depths, but are obtained by giving each depth weight in proportion to the amount of water represented.

[Parts per 100,000.]

	DATE.	NITROGEN AS NITRATES.						
		0	10	20	30	40	50	Average.
	1889.							
1	July 25,	.0000	.0086	.0180	.0300	.0133	.0050	.0140
2	Aug. 22,	.0040	.0027	.0047	.0100	.0093	.0060	.0056
3	Oct. 23,	.0050	.0050	.0070	.0040	.0060	.0050	.0054
4	Oct. 30,	.0060	.0060	.0060	.0040	.0030	.0030	.0052
5	Nov. 6,	.0080	.0080	.0080	.0080	.0060	.0100	.0078
6	Nov. 13,	.0120	.0100	.0090	.0110	.0050	.0090	.0097
7	Nov. 20,	.0080	.0100	.0120	.0100	.0070	.0060	.0097
8	Nov. 27,	.0120	.0120	.0120	.0180	.0150	.0150	.0136
9	Dec. 4,	.0300	.0200	.0300	.0300	.0220	.0220	.0262
10	Dec. 18,	.0250	.0280	.0280	.0230	.0230	.0200	.0259
11	Dec. 26,	.0320	.0300	.0280	.0320	.0300	.0320	.0303
	1890.							
12	Jan. 1,	.0250	.0250	.0300	.0350	.0325	.0300	.0290
13	Jan. 8,	.0340	.0340	.0350	.0360	.0250	.0250	.0336
14	Jan. 16,	.0300	.0250	.0400	.0380	.0350	.0400	.0331
15	Feb. 17,	.0350	.0380	.0350	.0320	.0350	.0300	.0352
16	March 18,	.0500	.0450	.0400	.0500	.0500	.0500	.0463
17	March 26,	.0350	.0400	.0450	.0480	.0550	.0500	.0436
18	April 4,	.0350	.0420	.0400	.0520	.0540	.0480	.0437
19	April 10,	.0600	.0550	.0480	.0500	.0400	.0480	.0515
20	April 17,	.0480	.0480	.0480	.0480	.0480	.0480	.0480
21	April 29,	.0600	.0480	.0550	.0430	.0620	.0280	.0533
22	May 8,	.0500	.0520	.0500	.0600	.0550	.0250	.0528
23	May 15,	.0500	.0400	.0450	.0600	.0480	.0060	.0474
24	May 22,	.0500	.0450	.0500	.0600	.0520	.0070	.0503
25	May 29,	.0350	.0400	.0500	.0500	.0500	.0060	.0442
26	June 5,	.0450	.0500	.0520	.0520	.0530	.0100	.0499
27	June 12,	.0380	.0350	.0400	.0400	.0300	.0060	.0367
28	June 19,	.0500	.0500	.0500	.0550	.0130	.0060	.0463
29	July 7,	.0050	.0052	.0420	.0450	.0100	.0040	.0220
30	July 18,	.0020	.0025	.0350	.0400	.0060	.0070	.0177
31	July 31,	.0030	.0020	.0450	.0280	.0070	.0080	.0177
32	Aug. 14,	.0030	.0050	.0400	.0300	.0080	.0150	.0180
33	Aug. 28,	.0150	.0150	.0400	.0200	.0150	.0150	.0216
34	Sept. 11,	.0120	.0080	.0150	.0080	.0150	.0150	.0111
35	Sept. 22,	.0080	.0020	.0150	.0150	.0100	.0150	.0096
36	Oct. 1,	.0150	.0100	.0100	.0100	.0100	.0150	.0109
37	Oct 9,	.0150	.0080	.0080	.0150	.0150	.0150	.0115
38	Oct. 16,	.0070	.0070	.0080	.0080	.0070	.0150	.0075
39	Oct. 24,	.0080	.0080	.0080	.0080	.0090	.0100	.0081
40	Oct. 30,	.0100	.0150	.0100	.0100	.0100	.0150	.0113
41	Nov. 6,	.0200	.0100	.0120	.0120	.0100	.0120	.0126
42	Nov. 13,	.0120	.0120	.0150	.0350	.0200	.0150	.0182
43	Nov. 20,	.0120	.0150	.0150	.0400	.0150	.0100	.0195
44	Dec. 2,	.0180	.0180	.0200	.0250	.0250	.0200	.0206

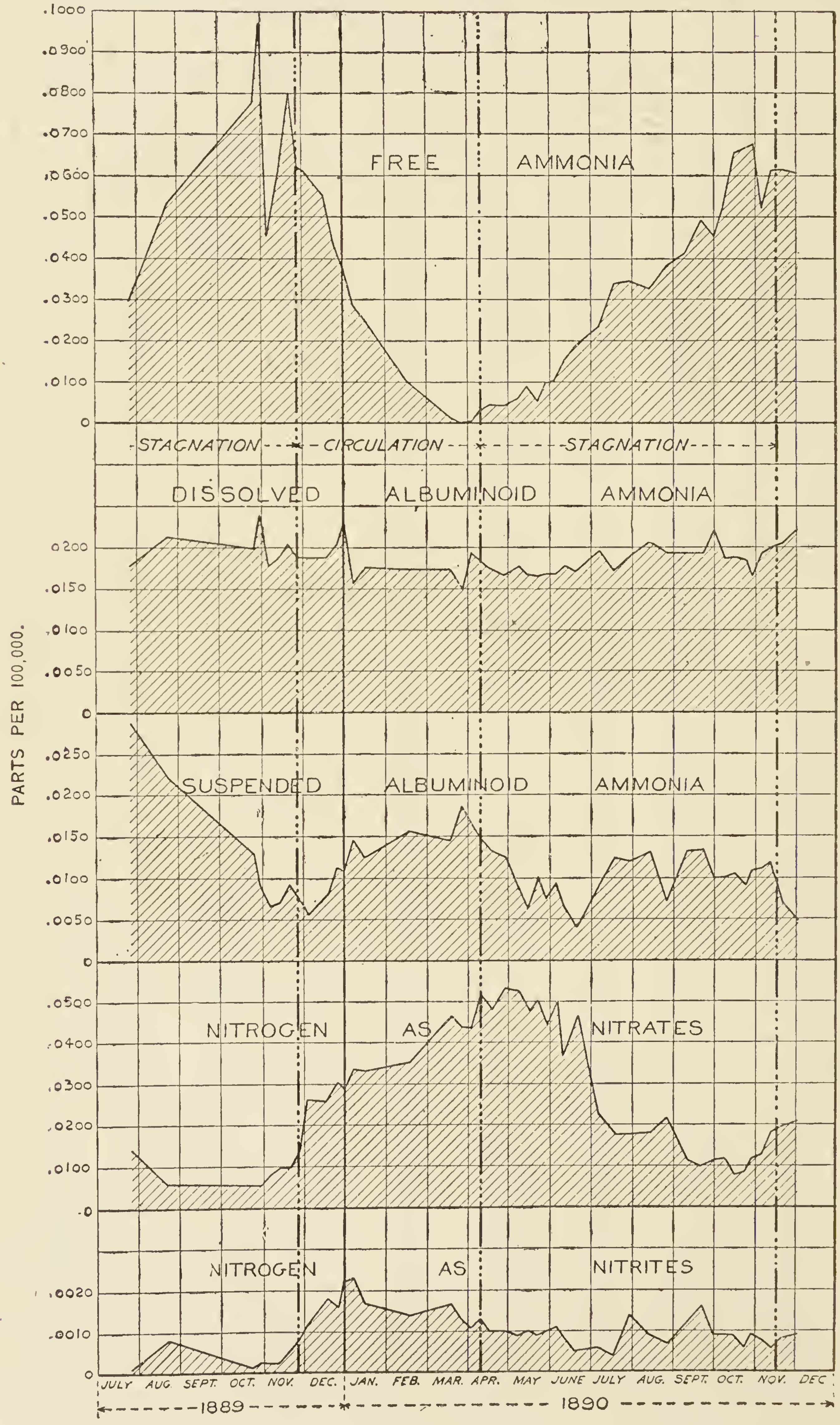
Table of Analyses of Jamaica Pond water at six depths — Concluded.

NOTE. — The averages given below are not a direct mean of the analyses at the different depths, but are obtained by giving each depth weight in proportion to the amount of water represented.

[Parts per 100,000.]

Nitrogen as Nitrites.							Average Nitrogen.			
0	10	20	30	40	50	Average.	Organic.	Inorganic.	Total.	
.0000	.0000	.0001	.0000	.0005	.0005	.0001	.0882	.0383	.1265	1
.0000	.0001	.0009	.0024	.0010	.0003	.0008	.0802	.0503	.1305	2
.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0591	.0691	.1282	3
.0001	.0001	.0001	.0004	.0005	.0004	.0002	.0584	.0847	.1431	4
.0001	.0001	.0002	.0002	.0001	.0001	.0002	.0426	.0453	.0879	5
.0003	.0002	.0002	.0002	.0001	.0000	.0002	.0454	.0599	.1053	6
.0003	.0004	.0004	.0004	.0012	.0007	.0005	.0527	.0760	.1287	7
.0009	.0008	.0007	.0007	.0008	.0009	.0008	.0466	.0653	.1119	8
.0012	.0012	.0012	.0012	.0012	.0012	.0012	.0423	.0776	.1199	9
.0017	.0017	.0018	.0019	.0019	.0019	.0018	.0478	.0729	.1207	10
.0016	.0016	.0016	.0016	.0017	.0017	.0016	.0565	.0671	.1236	11
.0018	.0023	.0024	.0024	.0021	.0018	.0022	.0605	.0625	.1230	12
.0023	.0024	.0024	.0021	.0023	.0021	.0023	.0557	.0594	.1151	13
.0017	.0017	.0016	.0017	.0016	.0017	.0017	.0540	.0557	.1097	14
.0014	.0014	.0014	.0014	.0014	.0014	.0014	.0607	.0450	.1057	15
.0017	.0017	.0017	.0015	.0016	.0017	.0017	.0583	.0491	.1074	16
.0013	.0013	.0013	.0013	.0013	.0021	.0013	.0629	.0449	.1078	17
.0010	.0012	.0010	.0010	.0010	.0012	.0011	.0662	.0455	.1117	18
.0013	.0013	.0013	.0012	.0012	.0012	.0013	.0606	.0552	.1158	19
.0012	.0010	.0012	.0010	.0010	.0010	.0010	.0561	.0525	.1086	20
.0010	.0009	.0009	.0009	.0012	.0015	.0010	.0532	.0575	.1107	21
.0009	.0009	.0008	.0009	.0009	.0020	.0009	.0471	.0586	.1057	22
.0011	.0011	.0009	.0009	.0009	.0015	.0010	.0403	.0567	.0970	23
.0009	.0009	.0008	.0009	.0009	.0025	.0009	.0474	.0556	.1030	24
.0009	.0009	.0008	.0009	.0015	.0025	.0010	.0430	.0533	.0963	25
.0009	.0009	0008	.0010	.0025	.0020	.0011	.0467	.0597	.1064	26
.0006	.0006	0007	.0007	.0015	.0012	.0008	.0417	.0502	.0919	27
.0006	.0004	.0004	.0007	.0004	.0004	.0005	.0360	.0623	.0983	28
.0008	.0006	.0004	.0007	.0003	.0000	.0006	.0510	.0419	.0929	29
.0000	.0000	.0001	.0020	.0001	.0001	.0004	.0538	.0458	.0996	30
.0000	0000	.0003	.0066	.0002	.0001	.0014	.0557	.0474	.1031	31
.0000	.0000	.0002	.0044	.0001	.0000	.0009	.0610	.0459	.1069	32
.0000	.0001	.0027	.0005	.0001	.0000	.0007	.0464	.0537	.1001	33
.0001	.0001	.0046	.0006	.0001	.0002	.0012	.0591	.0463	.1054	34
.0002	.0002	.0066	.0003	.0001	.0000	.0016	.0591	.0520	.1111	35
.0010	.0010	.0017	.0004	.0002	.0000	.0009	.0564	.0492	.1056	36
.0009	.0009	.0020	.0002	.0001	.0000	.0009	.0513	.0554	.1067	37
.0012	.0012	.0014	.0001	.0001	.0000	.0009	.0528	.0625	.1153	38
.0003	.0008	.0010	.0003	.0001	.0000	.0006	.0491	.0633	.1124	39
.0010	.0010	.0010	.0010	.0002	.0000	.0009	.0491	.0678	.1169	40
.0008	.0008	.0008	.0008	.0008	.0001	.0008	.0548	.0564	.1112	41
.0007	.0006	.0006	.0007	.0006	.0003	.0006	.0574	.0691	.1265	42
.0003	.0009	.0007	.0008	.0010	.0007	.0008	.0482	.0708	.1190	43
.0008	.0008	.0009	.0009	.0010	.0010	.0009	.0469	.0713	.1182	44

Diagram showing the Various Forms of Nitrogen in Jamaica Pond at different Seasons of the Year.



The next feature considered will be the seasonal changes, in the pond as a whole, of the various forms of nitrogen. These are shown by the columns of averages in the table on pp. 756–759; also graphically by the diagram opposite.

The most prominent feature of the diagram is the increase in free ammonia during the summer stagnation, and its disappearance during the period of circulation, which extended from November to April.

This increase, as already stated, is due to the accumulation of free ammonia in the lower layers of the water by the decomposition of organic matter; also in part to the deoxidation of the nitrates in these layers. The decrease takes place after the water in the bottom layers has, by the autumn circulation, been exposed to the air and mingled with the surface water, thereby losing its offensive gases and renewing its supply of dissolved oxygen so that nitrification can take place. That nitrification does occur is obvious from the correspondence between the increase in nitrates and the decrease in free ammonia. There is also, at the same time, an increase in the suspended albuminoid ammonia, showing that organisms, either directly or indirectly, appropriate a considerable portion of the nitrogen of the free ammonia.

The suspended albuminoid ammonia was higher at the beginning of the special examination than subsequently. It had been much higher previously, owing to an abnormally abundant growth of *Oscillaria*, which reached its maximum June 1, and was rapidly disappearing when the first special observations were made.

The dissolved albuminoid ammonia was remarkably constant throughout the whole period.

The fluctuations of the nitrites follow in a general way those of the nitrates; but the similarity is not very striking.

In addition to the above changes, which occur in the pond as a whole, the table on pp. 756–759 contains also the changes which occur at each of the depths examined. To present these changes graphically, and to show their relation to the temperature of the water, the diagram opposite the following page has been prepared. In order to avoid confusion of lines, the results obtained at the surface and at a depth of ten feet, which correspond closely, are combined; and those at a depth of twenty feet are omitted. The nature of the changes indicated upon the diagram has already been so thoroughly discussed that it will be unnecessary to refer to more than a few special features.

The most noticeable general feature is the coincidence of the lines which separate periods of stagnation and circulation, with the beginning of most of the changes which take place in the different forms of nitrogen.

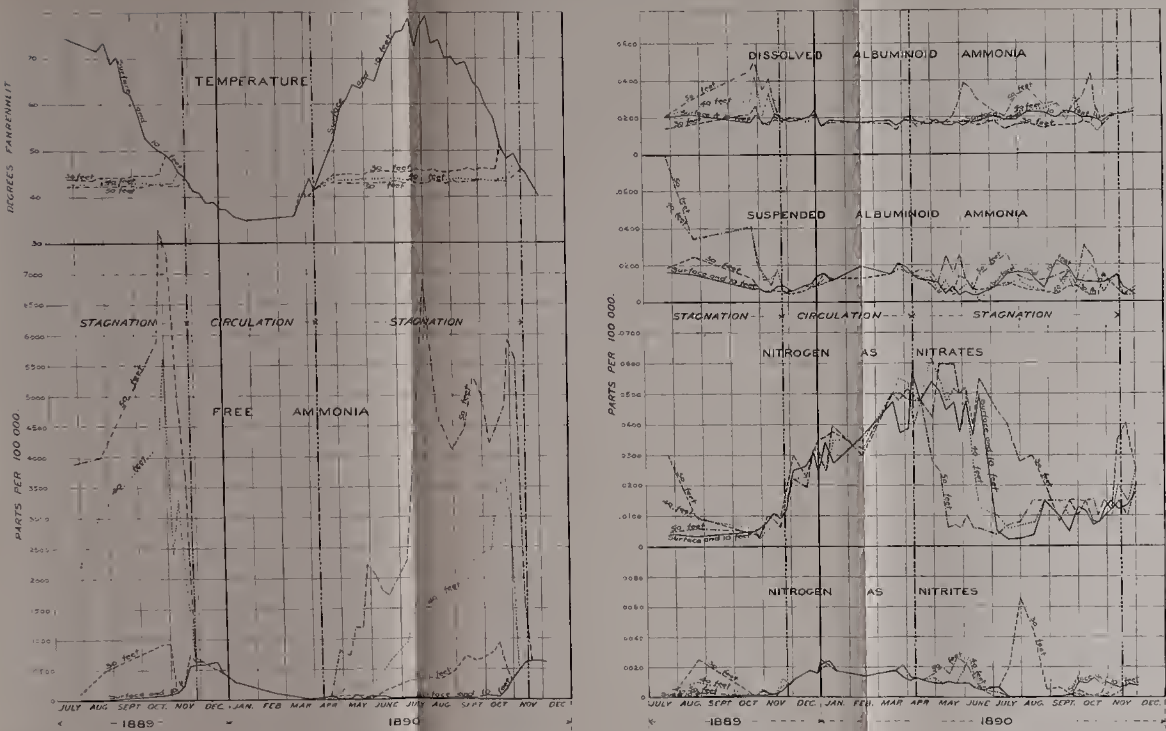
The decrease of the nitrates in the early part of the period of stagnation presents some peculiar features. The bottom layer was first affected, the nitrates decreasing from .0480, April 17, to .0060, May 15. Next the nitrates of the forty-foot layer diminished from .0530, June 5, to .0060, July 18. If we except for the present the surface observations, and confine the discussion to the stagnant layers, we find the next reduction in the thirty-foot layer, beginning June 19, at. 0550, and diminishing to .0080, September 11. The twenty-foot layer was next affected, the nitrates diminishing from .0400, August 28, to .0150, September 11.

These changes were accompanied by a corresponding increase in the amount of free ammonia, but not by any large rise in suspended albuminoid ammonia; all of which indicates that the decrease of the nitrates was due mainly to deoxidation, rather than to the appropriation of the nitrogen by microscopic green plants. This view is supported by the fact that the change first took place in the bottom layer, where the supply of free oxygen was first exhausted; also because the change was not simultaneous in different layers, though the number and kinds of green plants in each were nearly the same.

The decrease of the nitrates in the upper layers, where the water is kept in circulation all summer by the wind, took place between June 19 and July 7; that is, after a similar change in the forty and fifty-foot layers, and before one in the twenty and thirty-foot layers. The change in this case appears to be due to the appropriation of the nitrogen by green plants, which were more abundant at the latter date, both in the upper layers in which they grew and in the lower layers into which they sank. It is obviously not a case of reduction from nitrates to free ammonia, because the latter did not increase.

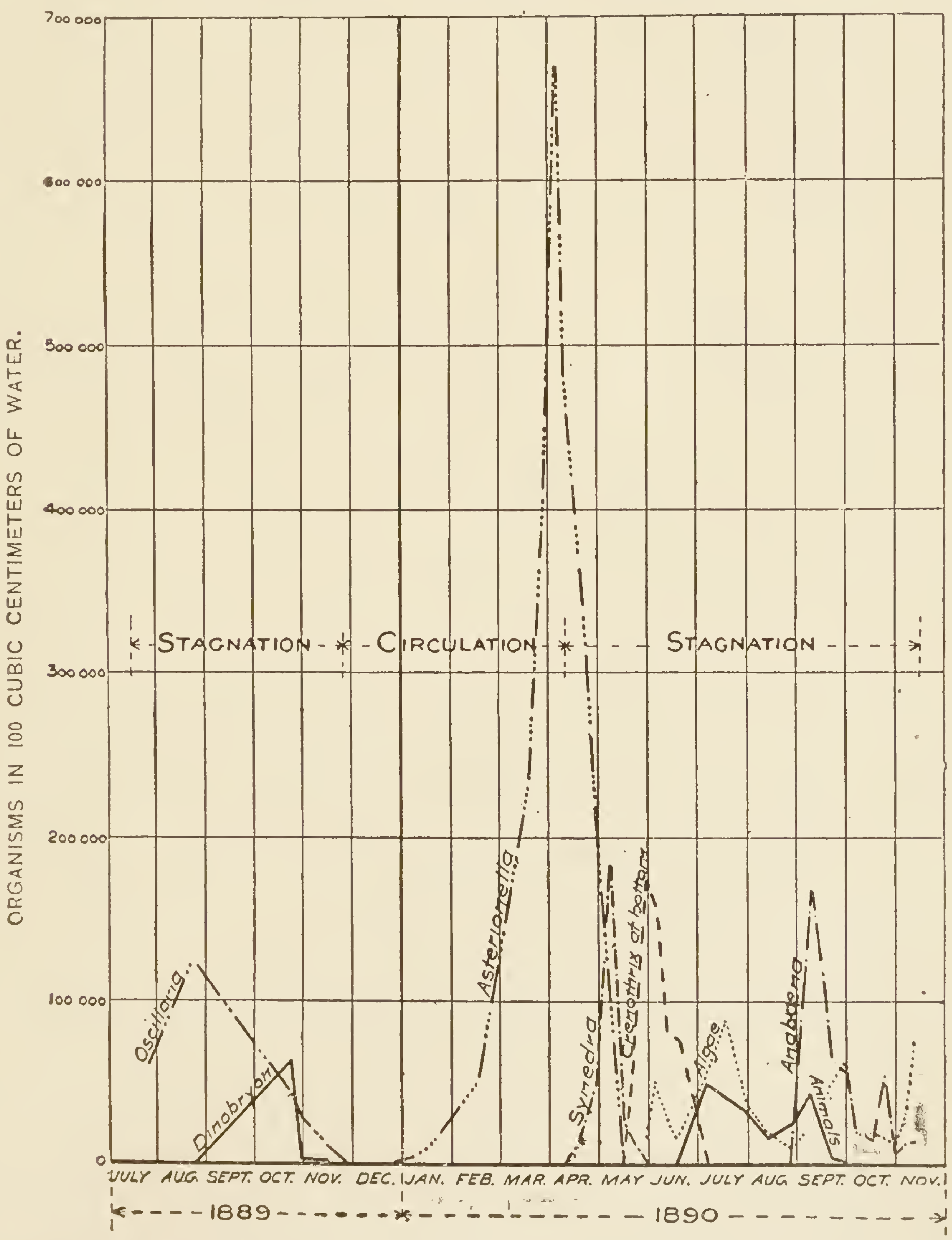
One other feature indicating the reduction of nitrates is a sudden rise of nitrites in the stagnant layers, followed by a corresponding fall. This occurred in the different layers in the same order as the decrease in nitrates, and at about the same time, and is most noticeable in the twenty and thirty foot layers. In the latter the nitrites were .0007, July 7, rose to .0066, July 31, and fell again to .0005, August 28. In the former, the nitrites were .0002, August 14, .0066, September 22, and .0017, October 1.

DIAGRAM SHOWING FLUCTUATIONS OF TEMPERATURE AND NITROGEN COMPOUNDS IN JAMAICA POND AT VARIOUS DEPTHS



The pond, on account of the large population on its watershed and its consequent high nitrogen, furnishes abundant food for organisms; and it is interesting to note the changes which occurred, as determined by microscopical examinations. At times the organisms were nearly all of one or two kinds, while at other times there was a great variety in the pond. An attempt has been made to show the principal changes graphically on the following diagram: —

Diagram showing Organisms in Jamaica Pond.



In general, the average number of organisms in the whole contents of the pond has been plotted according to the scale on the

left-hand side of the diagram. Exceptions have been made in the case of animals (including *Dinobryon*), which occur in much smaller numbers than the other organisms, and are therefore plotted on five times as large a scale, so as to give them sufficient prominence; also in the case of *Crenothrix*, which was found almost wholly in the bottom layer, so that the number in this layer only is indicated, and not the average for the whole pond.

As has already been stated, about two months before the special examination was begun there was an enormous growth of *Oscillaria* in the upper layers of the pond, so that the summit in the line representing this organism does not indicate the maximum, but rather a fluctuation in a generally decreasing quantity. During the time included in the diagram, the *Oscillaria* were mostly in the lower layers; and it is remarkable that, since their disappearance in November, 1889, none have been found in the water except on one or two occasions, and then only a few specimens. Shortly before the disappearance of the *Oscillaria* the animal *Dinobryon* became abundant, but disappeared suddenly at about the same time as the *Oscillaria*. During the month of December the water contained only a very few organisms, mostly animals of many different kinds. After this period came abundant growths of *Asterionella* and *Synedra*, and as these disappeared there was an abundant growth of *Crenothrix* in the bottom layer. While this organism was in the bottom layer and had almost sole possession of it, a great variety of algæ, including some *Asterionella* and *Synedra*, were present in the layers above, and their total number is shown on the diagram. A very abundant growth of *Anabæna*, which reached its maximum September 11, is shown separately from the other algæ. In this case an instance is presented of an organism appearing in great quantities which had been entirely absent from the water for more than a year.

The foregoing relates wholly to a pond which was selected for investigation because it was thought that it would exhibit in an extreme degree the changes which occur in a deep pond. To indicate how much other ponds and reservoirs differ from this, special examinations have been made of several during the period of stagnation, and the results are recorded in the tables on pp. 766, 767.

For more convenient comparison the following condensed table has been prepared, which gives the free ammonia at the surface and near the bottom of each of these ponds and reservoirs: —

Amount of Free Ammonia at the Surface and near the Bottom of Various Deep Ponds and Reservoirs during the Period of Stagnation.

LOCALITY.	DATE.	Depth of Pond or Reservoir. Feet.	Depth of deepest Sample. Feet.	FREE AMMONIA.	
				Surface.	Near Bottom.
Boston, Jamaica Pond, . .	Aug. 14, 1890, .	57	50	.0000	.4720
Wellesley, Waban Lake, . .	Aug. 27, 1889, .	36	35	.0012	.1760
Boston, Mystic Lake, . .	July 29, 1889, .	87	86	.0010	.1144
Boston, Reservoir 3, . . .	Aug. 1, 1890, .	21	20	.0028	.0696
Salem, Wenham Lake, . .	July 24, 1889, .	46	45	.0000	.0560
Boston, Lake Cochituate, . .	June 18, 1890, .	–	65	.0024	.0344
Boston, Reservoir 4, . . .	July 2, 1888, . .	46	40	.0000	.0008

It will be noticed by reference to the above table that there is a vast difference in the amount of free ammonia found near the bottom of the different ponds and reservoirs, and that there is only one exception to the rule that free ammonia accumulates during the summer in the bottom layers where the depth is twenty feet or more. The single exception is, rather strangely, not a natural pond, but a comparatively new artificial reservoir. The reasons for this appear to be, first, that the reservoir is not polluted; and, second, that all vegetable matter was carefully removed from it before filling with water. Each of the other bodies of water receives more polluting matter than this reservoir, and in most cases the amount of ammonia in the bottom water corresponds to the amount of pollution. In some years, as shown by observations of temperature at the surface and bottom, the water circulates to a greater depth during the summer than twenty feet, so that a reservoir like No. 3 of the Boston Water Works does not, under such circumstances, contain any accumulation of ammonia at the bottom.

Wellesley, Waban Lake.

Aug. 27, 1889.

[Parts per 100,000.]

Number.	Depth below Surface — Feet.	Temperature — Degrees Fahr.	Appearance.			Odor.		Ammonia.			Nitrogen as		Total Nitrogen.
			Turbidity.	Sediment.	Color.	Cold.	Hot.	Free.	Albuminoid.		Nitrates.	Nitrites.	
									Dis-solved.	Sus-pended.			
5109	1	73.4	Distinct.	Heavy, green.	0.70	Faintly vegetable.	Distinctly vegetable.	.0012	.0308	.0048	.0040	.0003	.0660
5110	10	70.2	Distinct.	Heavy, green.	0.70	Faintly vegetable.	Distinctly vegetable.	.0026	.0240	.0070	.0060	.0002	.0623
5111	20	57.6	Distinct.	Considerable red-brown, flocculent.	1.00	Distinctly disagreeable.	Distinctly disagreeable.	.0372	.0200	.0060	.0020	.0001	.0781
5112	30	48.6	Distinct.	Considerable red-brown, flocculent.	1.50	Distinctly disagreeable.	Very disagreeable.	.1186	.0244	.0074	.0020	.0002	.1547
5113	35	47.8	Distinct.	Considerable red-brown, flocculent.	2.00	Distinctly vegetable and disagreeable.	Very disagreeable.	.1760	.0210	.0126	.0030	.0001	.2085

Boston, Mystic Lake.

July 29, 1889.

4992	0	73.4	Slight.	Slight, green.	0.05	V'y faintly vegetable.	Faintly mouldy.	.0010	.0190	.0070	.0040	.C021	.0526
4993	20	63.3	Slight.	Slight, brown.	0.10	Faintly vegetable	V'y faintly vegetable.	.0044	.0168	.0052	.0450	.0100	.0970
4994	40	45.5	Very slight.	Very slight.	0.03	V'y faintly vegetable.	V'y faintly vegetable.	.0010	.0128	.0018	.0550	.0005	.0811
4495	60	42.8	Slight.	Slight, green.	0.03	Faintly mouldy.	V'y faintly mouldy.	.0000	.0124	.0008	.0780	.0005	.1005
4996	86	42.8	Slight.	Considerable, brown.	0.02	V'y faintly mouldy.	Very faint or none.	.1144	.0130	.0068	.0450	.0040	.1786

Boston, Reservoir III.

Aug. 1, 1890.

6330	0	79.8	Slight.	None.	0.40	Very faint or none.	Faintly vegetable.	.0028	.0250	.0040	.0050	.0005	.0572
6331	16	68.1	Decided.	Slight, red, flocculent.	0.50	Distinctly vegetable and musty.	Distinctly vegetable.	.0240	.0256	.0084	.0020	.0005	.0818
6332	20	65.3	Decided.	Considerable, flocculent.	3.50	Distinctly vegetable and disagreeable.	Decidedly vegetable and disagreeable.	.0696	.0380	.0048	.0020	.0007	.1326

Salem, Wenham Lake.

July 24, 1889.

[Parts per 100,000.]

Number.	Depth below Surface — Feet.	Temperature — Degrees Fahr.	Appearance.			Odor.		Ammonia.			Nitrogen as		Total Nitrogen.
			Turbidity.	Sediment.	Color.	Cold.	Hot.	Free.	Albuminoid. Dissolved.	Albuminoid. Suspended.	Nitrates.	Nitrites.	
4982	5	74.5	Slight.	Slight.	0.00	V'y faintly vegetable.	None.	.0000	.0140	.0066	.0020	.0000	.0387
4983	15	74.3	Slight.	Slight.	0.00	Very faint or none.	None.	.0004	.0158	.0038	.0030	.0000	.0371
4984	25	59.0	Distinct.	Slight.	0.02	None.	None.	.0000	.0128	.0064	.0030	.0000	.0373
4985	35	53.6	Distinct.	Considerable.	0.02	Very faint or none.	Very faint or none.	.0026	.0116	.0062	.0030	.0003	.0373
4986	45	49.6	Distinct. yellow.	Considerable.	1.00	Faintly vegetable.	V'y faintly vegetable.	.0560	.0148	.0110	.0100	.0004	.1036

Boston, Lake Cochituate.

June 18, 1890.

6087	1	67.5	Slight.	Very slight.	0.20	V'y faintly vegetable.	Faintly vegetable.	.0024	.0172	.0014	.0250	.0002	.0585
6088	35	50.0	Very slight.	Very slight.	0.30	None.	V'y faintly vegetable.	.0078	.0146	.0028	.0320	.0012	.0695
6089	65	45.0	Distinct, milky.	Slight.	0.70	V'y faintly musty.	V'y faintly musty.	.0344	.0168	.0030	.0300	.0003	.0925

Boston, Reservoir IV.

July 2, 1888.

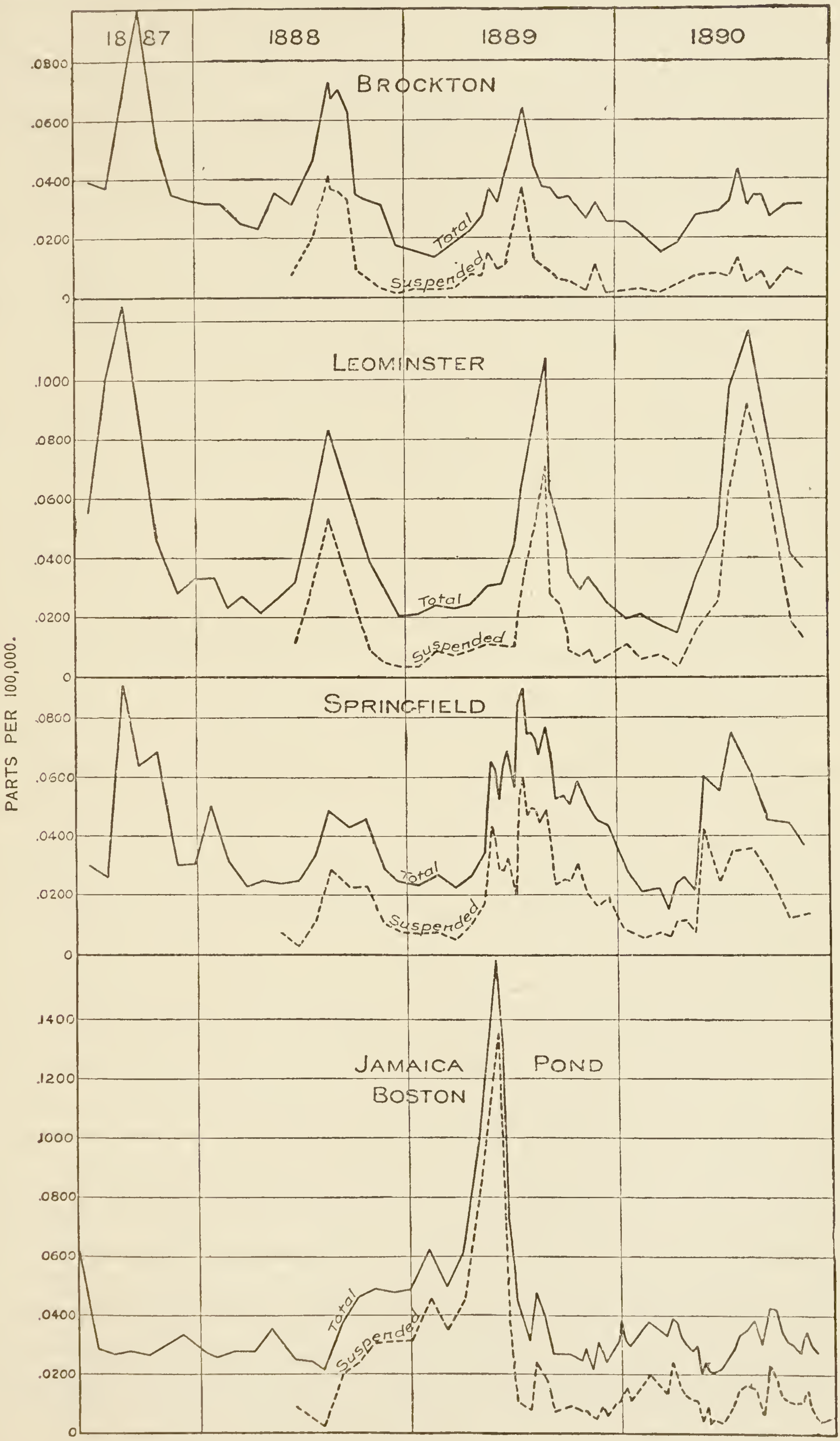
2701	1	–	Slight.	Slight.	0.70	Distinctly disagreeable.	Distinctly disagreeable.	.0000	.0234	.0034	.0050	.0001	.0507
2702	20	–	Distinct.	Slight.	0.40	Distinctly disagreeable.	Faintly disagreeable.	.0006	.0214	.0038	.0050	.0001	.0487
2703	40	–	Slight.	Slight.	0.70	V'y faintly disagreeable.	V'y faintly vegetable.	.0008	.0192	.0052	.0080	.0001	.0512

SPECIAL CHARACTERISTICS OF CERTAIN SURFACE WATERS.

Four surface waters in the State have been subject to much greater changes in character from the growth of organisms than any others which have been regularly examined. These are the Ludlow Reservoir, Springfield; the Haynes Reservoir, Leominster; the Reservoir at Brockton, and Jamaica Pond, Boston. The changes which

take place, being occasioned by the growth of algæ and other organisms, are best indicated in a chemical analysis by the suspended albuminoid ammonia; but, as this was not determined during the first year of the observations, it is necessary, in order to make that year's work available, to use the total albuminoid ammonia, which fluctuates in nearly the same way as the suspended. The fluctuations of both of these constituents are shown by the following diagram: —

Diagram showing the Total and Suspended Albuminoid Ammonia at Brockton, Leominster, Springfield and Jamaica Pond, Boston.



In comparing the lines representing the different waters, the general similarity of the first three, and their want of resemblance to the fourth, are very noticeable. To state the case more in detail, the albuminoid ammonia rises every year during the warm weather in the first three waters, reaching a maximum in the latter part of the summer or early autumn; while in the fourth the fluctuations do not occur annually, and the maximum point is reached earlier in the season. The rise in albuminoid ammonia in the first three waters is accompanied by an abundant growth of one or more of three kinds of blue-green algæ, namely, *Anabœna*, *Clathrocystis*, and *Cœlosphærium;* while the great rise at Jamaica Pond occurred when the water contained an enormous growth of *Oscillaria.*

The discovery that waters can be classified in this way appears to offer an opportunity for ascertaining the cause of the trouble: first, by a comparison of these waters and their environment with each other, in order to learn the features which they have in common; and, second, to compare them with waters not so affected, to ascertain in what respects they differ.

The features to which attention would naturally be given in a comparison of this kind are: the character of the organisms; pollution; depth, including the amount of shallow flowage; the character of the basin with regard to the presence or absence of vegetable matter in the bottom; if an artificial reservoir, the character of the land flowed, whether swamp or upland, cleared or wooded, and how prepared for flowage, whether by removing only trees and bushes above the surface of the ground, or by removing all soil, stumps and other vegetable matter; and the character of the water entering the basin.

In making a comparison of the organic growths in the first three reservoirs, it is found, as stated above, that the characteristic growths at the time of the rise in albuminoid ammonia are the blue-green algæ. Upon extending the comparison to other ponds and reservoirs in the State, it is found that, although these algæ are present in many instances at the same season of the year, yet with one exception they do not multiply to any very great extent, and consequently do not cause the same fluctuations in the chemical character of the water. This shows that the comparative freedom from trouble of other waters is not on account of the absence of these particular algæ, but rather because the conditions do not favor their multiplication. The single exception mentioned above is Horn Pond, in Woburn.

In comparing the three reservoirs as to their physical characteristics, we find that none of them are so deep but that the bottom water is brought to the surface in summer by every strong wind. All of them are artificial, none have had the vegetable deposits removed, and each covers some land which was formerly swamp or meadow. The Haynes Reservoir at Leominster is the poorest one of the three with regard to the general depth, the proportion of very shallow flowage, and the amount of swamp in the bottom. The Ludlow Reservoir at Springfield is much better in these respects, being nearly twice as deep as the Haynes Reservoir, containing very little shallow flowage, and a smaller proportion of swamp. The Brockton Reservoir is intermediate between the other two in the features mentioned, except that it contains a smaller proportion than either of land which was originally wet, and this was a meadow rather than a swamp. The water which enters this reservoir, however, coming to a considerable extent from swamps and meadows, is darker colored and contains more organic matter than that entering the other reservoirs.

The quantity of water entering the Brockton Reservoir during a year is three or four times the amount required to fill it, while the other reservoirs are filled on an average about once in nine or ten months.

Neither of the three reservoirs receives any considerable amount of sewage.

Judged by ordinary standards, the unfavorable conditions at Leominster are very much more prominent than at Springfield, and the peculiar trouble which is common to both places would naturally be expected to appear in an exaggerated form at the former place. It will be seen by reference to the diagram that this is the case, though not to the extent which might be expected when the great differences in the two reservoirs are considered. At Brockton the trouble was most serious in 1887, and has grown less and less every year since; so that, on the whole, this reservoir has been affected much less than the others, notwithstanding the fact that both the reservoir and the water entering it are worse than at Springfield, except that the reservoir at the former place has no extensive swamp in the bottom. Brockton has also the advantage that the water in the reservoir is changed more frequently.

In extending the comparison to the other reservoirs in the State which give less trouble or none, there are many which, judged by

the usual standards, are less favorably situated than that at Springfield, though there are not many which combine the features of a flowed swamp and infrequent change of water.

On the whole, it may be said of these three reservoirs that they possess no distinctive physical characteristics to which the special troubles can be *with certainty* attributed; but that there is the indication that the swampy bottoms and the infrequent change of water are important factors in the case.

There is one other point which may be referred to; namely, the degree of permanence of trouble of this kind. It seems reasonable to suppose that artificial storage reservoirs will in time assume the conditions of natural ponds, and this view is in accordance with the facts observed with regard to very old reservoirs. A change of this kind may, however, require a great many years. At Springfield the reservoir was built and its filling was begun in 1874. The next summer the trouble began, and it has recurred every year since; that is, for sixteen years in succession. In this case we are fortunate in finding on record frequent analyses of the water during the first two summers, made by the late Prof. Wm. Ripley Nichols. The amount of the trouble was then practically the same as in recent years, and there is, therefore, no indication of a cessation of the trouble in the near future. The city is now constructing additional works, with the view of abandoning the use of this reservoir, except as a reserve for cases of emergency.

The Brockton Reservoir was completed in 1880, but serious trouble was not experienced until 1885. In 1887 the maximum was reached, and it has been steadily decreasing since.

The Haynes Reservoir at Leominster was built in 1873, and has always given trouble, though records as to its severity are incomplete.

These facts show that under such circumstances a storage reservoir may continue to furnish bad water for a very long time, even if unpolluted by sewage.

Jamaica Pond differs greatly from the three reservoirs named in its physical characteristics, it being a natural pond, free from shallow flowage, and so deep that there is no interchange of water from the surface to the bottom in warm weather. It seems hardly possible that such an enormous growth of organisms as the water contained in the spring of 1889 could have been present if the nitrogenous food had not been supplied by the polluting matters, incident to the large

population on the watershed of the pond. On the other hand, it cannot be claimed that such growths as this will necessarily be produced by the same amount of pollution, because they only occur as the result of a number of favoring circumstances, both with regard to the condition of the organisms and of their surroundings. For instance, the great rise shown in the diagram on page 769 was occasioned by a growth of *Oscillaria*, which did not re-appear a year later, when the physical conditions were substantially the same, but was followed by successive growths of several other organisms, as previously indicated by the diagram on page 763.

The conclusion to be reached from this study of the waters which have usually contained abundant growths of organisms, and consequently given much trouble from bad tastes and odors, is practically the same as has already been reached, from the general study of the bad tastes and odors in ponds and reservoirs throughout the State; namely, that sources should be avoided which receive sewage either directly, or indirectly by filtration, and that reservoirs should be prepared for storing water by having the vegetable matter removed from their bottoms and sides.

THE NATURAL FILTRATION OF WATER.

When we speak of a ground water, we mean, ordinarily, the water found below the surface, which has had its origin in the intermittent filtration of rain and surface water. Ground water is usually clear, colorless and cool, nearly or quite free from organic matter, ammonia and nitrites; and, in regions remote from population, its contents of nitrates are low. The oxidizing power of porous earth is so great that we expect to find the ground water, even in localities with considerable population, nearly free from organic matter; though high nitrates, under these conditions, indicate that the water once contained a large quantity of nitrogenous organic matter.

In most of the ground-water supplies of the State, the water is obtained from wells or galleries alongside of streams or ponds. As instances, may be mentioned the water supplies of Milford, Newton, Brookline, Waltham and Watertown, which are all on the banks of the Charles River; the wells at Attleborough and North Attleborough which are on the banks of the Ten Mile River, those at Bridgewater on the Town River; the filter-gallery at Braintree

which is on the shore of Little Pond, and that at Woburn on Horn Pond. There are but few instances in the State where wells supplying large communities with water are situated in localities remote from a stream or pond. In the localities above mentioned, — and there are many similarly situated throughout the State, — the water percolates through porous strata into the galleries, both from the land side and also from the stream or pond.

It is in most cases perfectly filtered; that is to say, it is both clear and colorless. But it is important to observe the distinction that the water which comes from the land side is the result of slow, *intermittent* filtration, and contains little or no unoxidized organic matter; while that which filters into the well from the body of surface water is the result of *continuous* filtration, in which process little or no oxidation of organic matter goes on.

In intermittent filtration the suspended matters are removed, and the organic matter which the water may have contained is, under favorable conditions, completely oxidized; in continuous filtration through a considerable distance in porous earth, although the oxidation is quite insignificant, there is effected a removal of suspended matters and also in many cases of most of the dissolved organic matter, so that the water is not only rendered clear and colorless, but contains very much less impurity than it did in the stream or pond.

It is not to be supposed that all the water which filters into the well or gallery from the stream percolates, in all cases, directly through the intervening bank. Most of the water may take a more or less circuitous course, since the banks of a stream are often but slightly pervious to water, by reason of the very fine silt with which they are coated.

The relative amounts of water which, in any particular case, reach the well by continuous filtration from the stream or pond on the one hand, and by intermittent filtration from the land side on the other, we do not always know; but this we can in some cases ascertain by a comparison of the composition of the surface water and of the true ground water of the region with the water in the well. In a comparison of the water of Horn Pond in Woburn, and of the water from the land side as obtained by means of wells sunk at some distance from the pond, with the water in the filter-gallery, which is about one hundred and thirty feet from the pond, it has been determined that about four-fifths of

the water in the gallery is filtered pond water, and only the remaining one-fifth is ground water from the land side. Yet the purification is very decided; the organic matter represented by the albuminoid ammonia was, during the years 1887 to 1890, reduced from an average of .0383 parts in 100,000, to .0026 parts, a reduction of 93 per cent.; and the free ammonia from .0126 to .0012 parts, or a reduction of 90 per cent. But the nitrates under these conditions are not increased as they would be if the filtering process were intermittent and accompanied by the direct oxidation of the organic matter. In fact, we find the nitrates in the filtered water actually lower than in the water in the pond, being .0452 parts per 100,000 in the latter, and .0381 in the former. This is owing, without doubt, to an admixture of ground water from the land side, with lower contents of nitrates. Horn Pond affords a good opportunity for a study of filtration of this character, since the high chlorine contents from the refuse of tanneries, which flow in large quantity into the pond, make a decided contrast with the comparatively unpolluted ground water around the pond.

In the following comparison of the average composition of the water of Horn Pond, and of the water of the filter-gallery for three and one-half years, is shown the extent to which the purification of a water may be carried by a process of filtration which is mainly continuous: —

Comparison of the Water of Horn Pond and that of the Filter-Gallery on its Shore. — Average of Monthly Determinations for Three and One-half Years.

[Parts per 100,000.]

	Pond.	Filter-Gallery.
Turbidity,	Distinct.	None.
Sediment,	Considerable.	None.
Color,	0.33	0.00
Odor,	Considerable.	None.
Total residue,	11.31	11.69
Free ammonia,	0.0126	0.0012
Dissolved albuminoid ammonia,	0.0217	0.0024
Suspended albuminoid ammonia,	0.0150	0.0000
Nitrogen as nitrates,	0.0452	0.0381
Nitrogen as nitrites,	0.0013	0.0000
Total nitrogen,	0.1236	0.0434
Chlorine,	2.57	2.20

In the case of filter-galleries in other places, the chlorine contents of the adjacent body of surface water do not differ enough from that of the region to determine the proportion of water coming from the stream or pond; yet it is known that, in many instances, a not inconsiderable portion filters directly from these sources. This can be determined in some cases by the ratio of the excess of nitrogen to chlorine, as indicated on page 705, and in some by the albuminoid ammonia, which is higher than we find in ground waters well purified by oxidation in the process of intermittent filtration. This is shown in one instance in the following table: —

Comparison of the Water of Charles River with that in the Filter-Gallery of the Brookline Water Works.— Average of Monthly Determinations for Two Years.

[Parts per 100,000.]

	Turbidity.	Sediment.	Color.	Residue on Evaporation.	Ammonia.		Nitrogen as		Chlorine.
					Free.	Albuminoid.	Nitrates.	Nitrites.	
River, ...	Slight.	Slight.	0.81	5.07	.0013	.0254	.0094	.0001	.37
Filter-gallery, . . .	None.	None.	0.03	6.79	.0003	.0041	.0299	.0000	.53

The higher chlorine and nitrates in the water of the filter-gallery over that of the river is the result of the admixture of the ground water from the land side.

In contrast with these waters of wells and filter-galleries, which are the result of the mixture of waters from both intermittent and continuous filtration, may be given two instances of true ground waters which have their origin in intermittent filtration only. The first is a spring water from Williamstown, which, as is shown by its chlorine contents, has not been polluted by household wastes; and the second is a water from the wells at Eaton's Meadows in Malden, which shows in its high chlorine and nitrates that it was once considerably polluted. But it will be noticed that, as far as freedom from organic matter is concerned, the latter is as well purified as the former.

Analyses of Ground Waters practically free from Organic Matter, but differing widely in the Contents of Nitrates.

[Parts per 100,000.]

	Turbidity.	Sediment.	Color.	Residue on Evaporation.	Ammonia.		Nitrogen as		Chlorine.
					Free.	Albuminoid.	Nitrates.	Nitrites.	
Spring in Williamstown, .	None.	None.	0.0	13.96	.0001	.0007	.0486	.0000	0.07
Wells at Malden, . .	None.	None.	0.0	16.69	.0000	.0005	.4768	.0000	2.20

In nearly all the wells and filter-galleries in the State from which large supplies are drawn, the mechanical filtration is perfect; that is to say, the water is free from turbidity, and it is also without color. In a few cases, however, the well or gallery is so near a pond or reservoir, or the filters constructed beneath the pond itself are so imperfect, that the water which flows into the gallery is not even mechanically well filtered. In these cases very little water comes from the land side, and the water cannot be properly classified with the ground waters; it is rather an imperfectly filtered surface water.

There are three localities in the State where the water supply is of this character; namely, Arlington, Wayland and Whitman. The filter-gallery at Arlington is, in part, built on the shore of a storage reservoir on North Brook in Lexington, and in part beneath the bottom of the reservoir. A similar condition exists at Wayland, where the galleries are in connection with a storage reservoir on Snake Brook. At Whitman the galleries are in immediate proximity to the shores of Hobart's Pond.

A comparison of the analyses of these three waters, on pp. 13, 338 and 359 of this volume, with those of the waters of other wells or filter-galleries in the State, as, for instance, at Brookline, Hyde Park, Ware and Woburn, shows at once that we are dealing with a very different condition of affairs. The very imperfect character of the filtration is shown in the record of the turbidity, sediment and color. In the eighteen examinations of the water of the Arlington gallery, it was at no time clear or colorless, and the same is also true of the water from the galleries at Wayland and at Whitman. Indeed, the turbidity and sediment of the filtered water is not uncommonly greater than in the unfiltered water of the reservoir or pond.

Another result of this rapid filtration is a very marked increase in the free ammonia of the filtered water, indicating the decomposition of the nitrogenous organic matter contained in the unfiltered water, so that we have, as the result of filtration of this character, a positive deterioration of the quality of the water. The filtered water has, it is true, usually less color and also less albuminoid ammonia, in consequence of the straining out of some of the suspended algæ in the water; but in no other respects can the water be said to be improved.

In the following table the free ammonia in the filtered and unfiltered water from these three localities, as determined monthly during the years 1887 to 1890, are given side by side: —

Comparison by Months of the Free Ammonia in the Surface Water Reservoirs and Filter-galleries at Arlington, Wayland and Whitman.

[Parts per 100,000.]

	FREE AMMONIA.					
	ARLINGTON.		WAYLAND.		WHITMAN.	
	Reservoir.	Filter-gallery.	Reservoir.	Filter-gallery.	Pond.	Filter-gallery.
1887.						
June,	.0094	.0206	–	–	–	–
July,	–	–	.0022	.0280	–	–
August,	–	–	.0006	.0024	–	–
September,	–	–	–	–	–	–
October,	–	–	.0004	.0225	.0020	.0085
November,	–	–	.0036	.0021	–	–
December,	.0028	.0252	–	–	–	–
1888.						
January,	.0004	.0240	.0059	.0091	–	–
February,	–	–	.0046	.0203	–	–
March,	–	–	.0006	.0130	–	–
April,	–	–	.0002	.0072	–	–
May,	.0000	.0104	.0004	.0190	–	–
June,	.0000	.0258	.0004	.0156	–	–
July,	–	–	.0004	.0206	.0000	.0226
August,	.0000	.0186	.0016	.0244	.0012	.0218
September,	.0016	.0246	.0070	.0166	.0026	.0126
October,	.0020	.0020	.0032	.0216	.0046	.0058
November,	.0042	.0282	.0038	.0200	.0030	.0048
December,	.0004	.0064	.0002	.0022	.0018	.0060
1889.						
January,	.0006	.0164	.0014	.0016	–	–
February,	.0024	.0038	–	–	.0024	.0014
March,	.0080	.0012	.0014	.0012	.0022	.0074
April,	.0052	.0060	–	–	.0000	.0068
May,	.0012	.0000	.0012	.0026	.0086	.0126
June,	–	–	.0025	.0207	.0036	.0154

Comparison by Months of the Free Ammonia in the Surface Water Reservoirs and Filter-galleries at Arlington, Wayland and Whitman — Concluded.

[Parts per 100,000]

	FREE AMMONIA.					
	ARLINGTON.		WAYLAND.		WHITMAN.	
	Reservoir.	Filter-gallery.	Reservoir.	Filter-gallery.	Pond.	Filter-gallery.
1889.						
July,	–	–	–	–	.0044	.0180
August,	–	–	.0042	.0220	.0042	.0186
September,	–	–	–	–	.0044	.0226
October,	–	–	.0022	.0208	.0028	.0076
November,	–	–	–	–	.0046	.0024
December,	–	–	.0024	.0109	.0042	.0010
1890.						
January,	–	–	–	–	.0020	.0002
February,	–	–	.0004	.0152	.0004	.0006
March,	–	–	.0000	.0146	.0002	.0006
April,	–	–	–	–	.0028	.0028
May,	–	–	–	–	.0058	.0058
June,	–	–	–	–	.0054	.0076
July,	–	–	.0006	.0224	.0008	.0022
August,	–	–	–	–	.0014	.0054
September,	.0000	.0338	–	–	–	–
October,	–	–	.0008	.0108	.0018	.0116
November,	–	–	–	–	.0050	.0072
December,	–	–	.0036	.0116	.0038	.0036
Average,	.0024	.0154	.0020	.0143	.0030	.0084

A microscopic examination of the rusty sediment that settles out of these filtered waters on standing, shows it to be mainly composed of the fungus or bacterium *Crenothrix*. This thread-like organism needs for its life and growth the presence of iron in solution in its lower condition of oxidation, which the *Crenothrix* in some way separates from the water, and incorporates into its sheath in the higher condition of oxidation. The sediment has the appearance of hydrated sesquioxide of iron, which it is in large proportion; only by the aid of the microscope is the organic nature of the deposit revealed.

The presence of organic matter in the water is, of course, necessary to the growth of this organism; and it is believed that a condition of more or less advanced decomposition of the organic matter is favorable for its rapid development. This is what we might expect from the fact that *Crenothrix* is properly classed with the fungi or bacteria. Given favorable conditions, that is, a plentiful supply of decomposing organic matter in a water, and, at the same

time, sufficient quantity of iron in solution as protoxide, the rate of increase of this organism is something astounding.

The most striking instance of the growth of *Crenothrix* in a public water supply is the one well-known as the "water calamity" in Berlin, where the water supply derived from wells sunk near Tegel Lake had to be abandoned from this cause.

During the summer months the water from the Wayland filter-gallery often contains such a large quantity of this iron organism (which increases in amount in the pipes as the water passes from the filter to the village) that it is rendered practically unfit for use. In the two other cases of imperfect filtration, namely, Arlington and Whitman, *Crenothrix* is at times found abundantly, but it does not often, in these filtered waters, give rise to the serious annoyance which it occasions in the Wayland water.

Crenothrix thrives best in the warmer months, as might be expected, since the higher temperature is favorable to the rapid decomposition of organic matter; but a glance at the records of the microscopic examinations of the three waters mentioned shows that it may be found in all months of the year. It is likewise true that the free ammonia in these three filtered waters is, as a rule, higher in the warmer than in the colder months, but there are instances in which it is high also in the winter.

The recently published report, by Prof. Hugo de Vries, of the Rotterdam Crenothrix Commission, appointed to study the cause of the appearance of *Crenothrix* in the Rotterdam water supply,* establishes the fact that *Crenothrix* is not a ground-water organism, as had hitherto been supposed, but that it is very generally distributed in surface waters, and only becomes an annoyance by its rapid multiplication when the two necessary conditions co-exist; namely, decomposing organic matter in the water, together with iron in the state of protoxide. These two conditions are seldom found in surface waters exposed to the air, but in cases of rapid imperfect filtration they may readily co-exist.

In former investigations of this subject the chemical analyses of the surface and filtered waters have been insufficient to give any clue to the changes in the composition of the waters, under the conditions of rapid and imperfect filtration. The analyses which we

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* The reader is referred to an exhaustive article on *Crenothrix* in water supplies, by Prof. W. T. Sedgwick, in the "Technology Quarterly" (Boston) for December, 1890, which contains a summary of this report.

now possess of the waters of Arlington, Wayland and Whitman throw much new light on this subject. The very striking increase of the free ammonia in these cases of imperfect filtration has already been mentioned. This points to decomposition in progress either of the organic matter in the water itself, or of that contained in the porous media through which the water filters. In this decomposition of organic matter the oxygen dissolved in the water is used up, and under these conditions the iron in solution as sesquioxide is reduced to the protoxide, and thus both of the necessary conditions for the rapid multiplication of the *Crenothrix* are brought about. Furthermore, the absence of light where these changes are going on is favorable for bacterial growth. More study of the subject is needed, to determine the cause of this rapid decomposition of the organic matter in rapid filtration, and also to ascertain whether the presence of *Crenothrix* has any influence in promoting this decomposition. But the above theory of the cause of the rapid development of *Crenothrix*, in the three cases under consideration, is consistent with the facts which we now possess on this subject.

In the case of ground waters which are perfectly filtered, in which practically all the organic matter has been removed by oxidation as the result of intermittent filtration, or by long contact with porous strata in continuous filtration, we do not have trouble from *Crenothrix*, nor do we have evidence of recent decomposition in the presence of free ammonia.

It is true that the biological records in the preceding pages show the occasional presence of *Crenothrix* in considerable quantity, in other ground-water supplies than those we have been considering. In such cases it may be that the conditions of filtration were at the time imperfect, or that subsequent decomposition had been in progress, since we not infrequently find that *Crenothrix* increases in the dead ends of the pipes.

Notwithstanding the general distribution of *Crenothrix* in natural surface waters, the cases in which serious annoyance arises from its abundant growth are comparatively few. This is doubtless due to the fact that there is lacking the coincidence of the two conditions necessary for its life, namely, decomposing organic matter and iron in solution as protoxide.

The generally accepted statement that good ground waters are free from bacteria finds confirmation in the results of the bacterial examinations which have been made of some of the waters of wells

and filter-galleries of the State. It has been found that those waters which are shown on chemical examination to have been well purified by filtration are nearly or quite free from bacteria, notwithstanding the fact that the waters before filtration may have been polluted and contained bacteria in large quantities. This statement applies only to waters in covered wells and galleries which have not been exposed to the air.

THE POLLUTION

AND

SELF PURIFICATION OF STREAMS.

By FREDERIC P. STEARNS,

ENGINEER OF THE BOARD.

THE POLLUTION OF STREAMS.

There are many instances in which sewage is discharged into a stream without producing a degree of pollution which is apparent to the senses, or which is seriously objectionable where the stream is not used for the purposes of domestic water supply. On the other hand, it frequently happens that a stream receives so much sewage that it becomes very foul and offensive to those living near it.

The dividing line between these two conditions must always remain somewhat indefinite, both on account of a difference of opinion as to what degree of pollution is permissible, and because of the great difference in the conditions at different places, such as, for instance, the character of the sewage; the fluctuations in the flow of the stream, occasioned by its use for mill purposes; the existence of mill ponds in which sewage deposits may accumulate; and the presence of population along the banks below the point where the sewage is discharged. At the present time the dividing line is rendered still more indefinite by a lack of information as to the effect of a given quantity of sewage upon a given quantity of water.

The investigation of the rivers in Massachusetts furnishes some information upon this subject, which will be presented in this section.

There are some instances in which the polluting matter from factories is more important in its visible effect upon a stream than domestic sewage; but in a great majority of cases, where the population is provided with sewers discharging into a stream, the domestic sewage is the controlling factor. In attempting to determine a permissible ratio between the amount of sewage and water, we are confronted by another trouble; namely, the variable amount of polluting matter contained in sewage from different communities; but, as this is due to the different amounts of water used in different places rather than to variations in the amount of polluting matter contributed per person, this difficulty will be avoided if we adopt as a basis for calculations the relation of the population to the quantity of water flowing in the stream. The volume flowing in streams is commonly expressed in cubic feet per second; but, in

adopting this as a unit, it is necessary, in order to avoid too small quantities, to make the unit of population 1,000.

The quantity of water which will dilute the sewage of 1,000 persons sufficiently to render it unobjectionable for all purposes except drinking can be determined by two methods: first, by actual experience in the discharge of sewage into streams, where the population connected with the sewers and the volume of water flowing in the stream are known; and, second, by determining by chemical analysis the composition of the water of a stream which has been polluted by sewage to the greatest permissible extent, and then determining by calculation what relation of population to volume of water will produce the same composition.

The effect which the sewage of a given population may be expected to produce upon the composition of the water into which it is discharged will be understood best if the second method is first discussed. In order to make the calculations there referred to, it is necessary to know the actual amount of one or more constituents contributed to sewage per inhabitant, which can be determined best from analyses of sewage where the contributing population and the quantity of sewage are known, together with the corresponding analysis of the water supply which by the pollution became sewage. These data are accessible in the report of the Royal Commission on Metropolitan Sewage Discharge, 1884, which contains 181 analyses made by Mr. W. J. Dibden of samples collected so that they would fairly represent the average London sewage, and in the monthly reports of the water supply of the metropolis. Estimating from the population and the dry-weather flow of sewage at this time, the volume equalled 37 United States gallons per person per day; but, in order to allow for a little rain-water at the time when some of the samples were collected, the average volume is estimated at 40 gallons per person per day, equal to 333 pounds.

The analysis of this sewage and the corresponding average analysis of the water supplied to London at the same time are as follows, the figures given representing parts per 100,000:—

	Free Ammonia.	Albuminoid Ammonia.	Dissolved Solids.	Chlorine.
Sewage,	4.5160	0.5471	84.7	15.0
Water,	0.	0.0078	27.5	1.62
Difference,	4.5160	0.5393	57.2	13.38

These differences represent the matter added to the water to make it sewage, and from them and the known weight of sewage per person (333 pounds) the absolute amount of each of these constituents contributed per person may be estimated with the following results : —

Free Ammonia.	Albuminoid Ammonia.	Dissolved Solids.	Chlorine.
.015 pounds.	.0018 pounds.	.191 pounds.	.045 pounds.

The volume of sewage with the corresponding population and analyses are not available in any other place where the sewage is of normal character, except London ; but the relative amounts of the different constituents can be determined at other places, as, for instance, at Lawrence and Worcester, Mass. The average analyses of water and sewage at Lawrence, as given on pp. 183 and 538, are as follows, the figures representing parts per 100,000 : —

	Free Ammonia.	Albuminoid Ammonia.	Dissolved Solids.	Chlorine.
Sewage,	1.8202	.5302	35.63	5.25
Water,	.0014	.0107	3.83	0.21
Difference,	1.8188	.5195	31.80	5.04

Analyses of Worcester sewage, made in 1872, and recent analyses of the water supply, are as follows : —

	Free Ammonia.	Albuminoid Ammonia.	Dissolved Solids.	Chlorine.
Sewage,	1.8760	.3160	25.35	4.17
Water,	.0020	.0158	2.65	.14
Difference,	1.8740	.3002	22.70	4.03

If at each of these three places the amount of free ammonia is assumed as the unit, the ratio of the other constituents to it is as follows : —

	Free Ammonia.	Albuminoid Ammonia.	Dissolved Solids.	Chlorine.
London,	1	0.12	12.7	3.0
Lawrence,	1	0.29	17.5	2.8
Worcester,	1	0.16	12.1	2.2

If the amount of free ammonia contributed per person at each of these places is the same as at London, then, by calculation from these ratios, the amount of each of the other constituents would be : —

	Pounds.			
London,	.015	.0018	.191	.045
Lawrence,	.015	.0043	.262	.042
Worcester,	.015	.0024	.181	.033

Making an average of the above by allowing the observations at London and Lawrence full weight, and those at Worcester half weight, the quantities given below are obtained, which may be adopted, for further calculations, as the standard amounts of each of these constituents contributed daily per inhabitant to change water into sewage : —

Free Ammonia.	Albuminoid Ammonia.	Dissolved Solids.	Chlorine.
.015 pounds.	.003 pounds.	.218 pounds.	.042 pounds.

Using these figures as a basis, we may determine the parts per 100,000 of each of these constituents added to water to make sewage of different degrees of dilution. In most cases the amount of each originally contained in the water is so small that it may be neglected, in which case the calculated quantity will represent the actual composition of the sewage.

Calculated Composition of Sewage of Different Degrees of Dilution.

[Parts per 100,000.]

Volume of Water per capita. (Gallons).	Ammonia.		Dissolved Solids.	Chlorine.
	Free.	Albuminoid.		
40	4.50	.90	65.4	12.6
50	3.60	.72	52.3	10.1
60	3.00	.60	45.3	8.4
70	2.57	.52	37.4	7.2
80	2.25	.45	32.7	6.3
90	2.00	.40	29.1	5.6
100	1.80	.36	26.2	5.0
120	1.50	.30	21.8	4.2
150	1.20	.24	17.4	3.4

If the above table is continued so as to include much greater degrees of dilution, then we have presented the conditions which obtain when sewage is discharged into streams. In this case, however, as the dilution becomes greater and the effect of the polluting matters of the sewage less and less marked, it becomes more necessary to take into account the original composition of the water with which the sewage is mingled. In addition to this no allowance is made for the loss of free and albuminoid ammonia, which sometimes takes place when sewage is highly diluted, as will be shown subsequently.

Amounts of Ammonia, Dissolved Solids and Chlorine added to Streams by Domestic Sewage for Various Ratios of Population to Quantity of Water flowing.

[Parts per 100,000.]

Volume of Water.		Ammonia.		Dissolved Solids.	Chlorine.
Cubic Feet per Second per 1,000 Persons.	Gallons per Capita per Day.	Free.	Albuminoid.		
0.5	323	.5580	.1114	8.10	1.56
1.0	646	.2790	.0557	4.05	.78
1.5	969	.1860	.0371	2.70	.52
2.0	1,292	.1395	.0278	2.02	.39
2.5	1,615	.1116	.0223	1.62	.31
3.0	1,938	.0930	.0186	1.35	.26
4.0	2,584	.0697	.0139	1.01	.19
5.0	3,230	.0558	.0111	0.81	.16
6.0	3,876	.0465	.0093	0.67	.13
7.0	4,522	.0399	.0080	0.58	.11
8.0	5,168	.0349	.0070	0.51	.10
9.0	5,814	.0310	.0062	0.45	.09
10.0	6,463	.0279	.0056	0.40	.08
15.0	9,694	.0186	.0037	0.27	.05
20.0	12,926	.0139	.0028	0.20	.04
30.0	19,389	.0093	.0019	0.13	.03
40.0	25,852	.0070	.0014	0.10	.02
50.0	32,315	.0056	.0011	0.08	.02
100.0	64,630	.0028	.0006	0.04	.01

In order to make practical use of this table in determining the greatest amount of domestic sewage which can be turned into a stream without making it offensive, it is necessary to compare the

calculated analyses of the table with observed analyses of polluted streams. In making such comparisons, the free ammonia, which is the characteristic feature of sewage, and which is found only in extremely small quantities in unpolluted streams, is the best index.

The Blackstone River, a short distance below the point where it receives the sewage of Worcester, contained on an average during the two years ending June 1, 1889, 0.2160 parts per 100,000 of free ammonia. The stream at this place is very foul and offensive. At Uxbridge, sixteen miles further down stream, where the sewage is further diluted to a considerable extent by cleaner water from the tributaries, the average free ammonia was 0.1011. The water at this place is so much polluted as to affect its quality for manufacturing purposes, but it is not generally offensive to those living on the banks of the stream. At Millville, in the town of Blackstone, still further down stream, where the dilution is still greater, the average free ammonia is 0.0455, and the river is inoffensive. The odor of the water, however, when a sample is agitated in a bottle, as observed by the chemist, is generally musty and disagreeable, and on a few occasions offensive. The free ammonia at this place was at one time as high as 0.0896.

Stacy's Brook in Swampscott, during the time of its examination, received much sewage from the easterly portion of Lynn, and contained on an average 0.1858 parts per 100,000 of free ammonia. The stream has a foul appearance, and the samples generally had an offensive odor even during those portions of the year when, on account of the high flow, the free ammonia was considerably less than the average above given.

A single sample from Pegan Brook, Natick, collected in June, 1889, and having 0.1200 parts of free ammonia, was characterized by the chemist as having a distinctly musty odor when cold, and a strongly musty and disagreeable odor when hot.

Samples taken in September, 1888, from Coachlace Brook in Clinton, which is a very foul stream, had an average free ammonia of 0.1955, and an offensive odor. The pollution of this stream is partly by sewage and partly by wool-washing refuse. At the same time four samples were taken from the mouth of the south branch of the Nashua River, below Coachlace Brook, which had an average free ammonia of 0.0264. The odor of the samples was faint, and the river did not have a noticeable odor when the samples were collected. In one of the samples the free ammonia was 0.0444.

Two samples collected from the Charles River, below Milford, where it is a very small stream, one taken a week later than the other, in July, 1890, contained respectively .1570 and .1320 parts of free ammonia. The first had only a faint odor, and the second was decidedly offensive. This case is introduced, in part, for the purpose of showing that the amount of ammonia is by no means an unfailing index of the amount of odor from sewage. It is, however, the best index that we have where the pollution is occasioned by domestic sewage.

Several instances might be enumerated of streams which are polluted by sewage so that the water contains from 0.0100 to 0.0300 parts of free ammonia, without having offensive odors.

It will be seen that the foregoing data are insufficient for reaching a definite conclusion, and a further study of the subject is very much needed. In the mean time, however, it is necessary to solve practical problems, and it is therefore desirable to limit the debatable ground as far as may be justified by the observations. For this purpose two lines have been drawn across the table on page 789, to include those ratios of population to volume concerning which there may be doubt. These lines include volumes from 2.5 to 7.0 cubic feet per second per 1,000 persons, and free ammonia from 0.0399 to 0.1116.

With smaller volumes of water, the pollution is so great as to be inadmissible. With larger volumes, the pollution is so small as to be clearly admissible from the stand-point of the offensiveness of the water. From other stand-points, however, such as the use of water for certain manufacturing purposes, the amount of dilution should be greater; and in a stream used for domestic water supply it cannot be said, with our present knowledge, that any degree of dilution will make the water entirely safe for use.

All of the foregoing relates to the pollution of the water itself, as if the sewage emptied into a stream of unvarying volume, flowing with sufficient rapidity to prevent deposits. If, instead, the sewage is turned into a stream where it is ponded by a dam, or if there are ponds on the stream below the point of discharge, the solid particles of the sewage may accumulate and decompose, giving off offensive gases. This is more likely to occur if the deposits are covered with foul water in which the dissolved oxygen has been used up, because the decomposition will then be putrefactive rather than a process of oxidation. The fluctuations in the height of a stream, where they

cause large areas to be alternately covered with water, and left bare, are also unfavorable for the proper disposal of sewage. In short, there are many things, such as the variations in the volume flowing in a stream occasioned by its use for mill purposes, the amount and character of manufacturing wastes, and the subsequent use of the water for different kinds of manufacturing, which require careful consideration in each case, and often a considerable variation from any general rules which may be laid down.

The other method of determining the ratio of population to flow of streams, referred to in the early part of this section of the report, depends upon observations of the effect of discharging the sewage of a given population into a stream of known size. In this State there are but two streams where a comparison of this kind is practicable; namely, the Blackstone and Merrimack rivers. The former has discharged into it the sewage of the city of Worcester, with an estimated population, in 1888, of 76,500. The total population above the point where samples were collected was at the same time 77,500. The volume of water flowing in the river during working hours was determined, but not the total quantity flowing in the whole twenty-four hours.

In order to obtain the latter quantity, which is needed for these comparisons, it is necessary to make use of the flow per square mile of drainage area, as determined by the actual measurement of the flow of some other stream having a known drainage area. The Sudbury River measurements for the period under consideration, as given on page 655 of this volume, are the most applicable to this case.

The average flow of the Blackstone River for the period under consideration, reckoned upon this basis, was 122 cubic feet per second; and, if we assume that the river received the sewage of 70,000 of the population, then the volume per 1,000 persons would be 1.77 cubic feet per second. The amount of pollution at this place, as already stated, is much greater than is permissible. At Uxbridge, which is sixteen miles further down stream, the flow upon the basis above given is 279 cubic feet per second; and, if we assume that the sewage of 3,000 persons enters the river between Worcester and Uxbridge, making a total of 73,000, the volume flowing per 1,000 persons was 3.88 cubic feet per second. The water at Uxbridge was so much polluted that its quality for manufacturing purposes was affected, but it was not generally offensive to those living upon

the banks of the stream. The amount of pollution at this place was increased somewhat by the manufacturing refuse turned into the river below Worcester.

The Merrimack River will be considered with reference to the effect of the sewage of Lowell upon it. In this case observations for more than three years are available. The average flow of the river has been 8,720 cubic feet per second, and the average population of Lowell for the same time 74,500; hence, the volume flowing has equalled 117 cubic feet per second, per 1,000 persons. If, instead of the average flow, we take the low-water flow of 2,200 cubic feet per second, and the population as given by the census of 1890, the volume per 1,000 persons is 28 cubic feet per second. It will be observed that the former of these results represents a greater dilution than any indicated by the table on page 789, while the latter shows a dilution four times as great as the highest about which there is any doubt. The discharge of this sewage into the river, added to that which has already entered it from cities and towns above, together with a vast amount of manufacturing sewage, has not affected the water enough to prevent the city of Lawrence, ten miles below, from adopting and maintaining a water supply from this source; although the danger to health which has been found to exist in this water supply has led the city authorities to contemplate the introduction of water from a new source. This is a striking instance of the extent to which a great river can dilute the sewage of a very large population; but the fact that the water is not worse than it is, is undoubtedly due in part to the so-called self-purifying power of streams, which will now be discussed.

SELF-PURIFICATION OF STREAMS.

This subject may be discussed with reference to the subsequent use for drinking of water which has been polluted by sewage, or from the other stand-point of rendering inoffensive a stream which has been made offensive in the same way. In the case of the stream used for drinking, chemical purification is less important than the destruction of disease germs, so that the purification should be considered from a bacterial as well as a chemical stand-point; while in the case of the offensive stream the improvement is well indicated by chemical analysis alone.

The investigation of rivers in Massachusetts has been almost wholly chemical, and the subject will therefore be discussed mainly from this stand-point. In comparing a sample of water taken from a stream at a point where it is much polluted with one taken further down stream, there is often a very marked improvement in the quality of the water at the lower point, owing to the dilution caused by purer tributaries, and by water filtering into the stream from subterranean sources. It is only when the effect of this dilution is eliminated that we can determine the chemical changes which have taken place, as a result of the purifying action of the stream.

The Blackstone River furnishes a good illustration of a change due largely to dilution. The chlorine just below Worcester is 1.19 parts per 100,000, while at Millville it is but 0.46. As the chlorine compounds found in water are very permanent, this cannot be attributed to a reduction in the actual amount of chlorine, but rather to its diffusion in a greater amount of water. This is known to be the case in this instance, as there is added to the water which flows past Worcester, before it reaches Millville, three times its own volume of water containing much less chlorine.

If, instead of comparing analyses directly, we make use of them in connection with the amount of water flowing to determine the number of pounds of each constituent actually carried by the river in a given time, we eliminate the effect of dilution, except that the number of pounds found at the lower station includes not only the amount put in at the upper one, with such modifications as may be due to the purifying action of the stream, but also the number of pounds of each constituent added at intermediate points, both from natural and artificial sources.

In the case of the Blackstone River, the amount of impurity in the water just below Worcester is so great, in comparison with that entering the stream between this place and stations further down the stream, that it is feasible to reach conclusions of some value as to the purifying effect of the stream, without making any allowance for the added impurities. More accurate results can be obtained, however, by making corrections for the impurities added to the river from natural sources. This can be done with a fair degree of accuracy, notwithstanding the fact that no analyses of the tributaries have been made, because the quantity of water brought in by tributary streams is proportionate to their watersheds, and the general

character of unpolluted surface waters in this vicinity is known. No correction is necessary in the case of the free ammonia, because the amount naturally found in streams is insignificant when compared with that entering the river from sewage. The correction for chlorine is the largest one, and this is definitely known from the normal chlorine of this region. The corrections for albuminoid ammonia and nitrates are less accurate.

It has not been found practicable to make a correction for the artificial pollution, because the population sewering directly into the stream and the character and extent of the manufacturing wastes are unknown. In consequence of the omission of this correction, any purification which may be found to have taken place between Worcester and a point below occurs notwithstanding the artificial pollution added to the stream at intermediate points.

Two tables are given below: the first shows the average number of pounds per day of free and albuminoid ammonia, nitrates and chlorine passing Worcester, Uxbridge and Millville during the two years ending May 31, 1889; the second table is the same as the first, except that the quantities passing the two lower stations are diminished by the amount of each constituent naturally brought in by tributaries below Worcester.

Table showing the Amounts of Different Constituents in the Water which passes Three Points on the Blackstone River.

[Pounds per day.]

LOCATION.	Ammonia.		Nitrogen as Nitrates.	Chlorine.	Total Nitrogen.
	Free.	Albuminoid.			
Worcester,	1728	826	218	8630	.3000
Uxbridge,	1629	454	491	10406	.2581
Millville,	1299	734	611	13166	.2891

Same as Above, except that the Quantities at Uxbridge and Millville are reduced to allow for the Impurities naturally brought in by Tributaries below Worcester.

[Pounds per day.]

LOCATION.	Ammonia.		Nitrogen as Nitrates.	Chlorine.	Total Nitrogen.
	Free.	Albuminoid.			
Worcester,	1728	826	218	8630	.3000
Uxbridge,	1629	306	426	8738	.2272
Millville,	1299	382	457	9205	.2156

Before drawing any conclusions from the tables, it may be well to indicate the limitations of accuracy of these investigations. The samples collected just below Worcester were usually obtained on week days in the latter part of the forenoon, and consequently represented the morning flow of sewage diluted with the flow of the river during working hours. Samples were taken at the lower points a day or two later than at Worcester, but the time was not sufficient to permit the water to pass from Worcester to these stations. If a longer time had elapsed, there was greater danger that the comparison might be affected by intervening rains, which would increase the dilution at the lower stations. In any method of collection with points so far apart on a stream containing many mill ponds, there is no assurance that any given sample at the lower station represents the day or night flow of sewage at the upper station. In view of these conditions affecting the accuracy of the results, it is obvious that too much stress should not be laid upon small variations in the quantity of any constituent, and it even seemed somewhat doubtful whether the average of observations as given in the table would be trustworthy. To test this point, the results obtained at different periods have been compared. Those given in the table are, as already stated, based upon the analyses of the first two years, and the flow of the river as deduced from the areas of the watersheds above the different points, in connection with the recorded yield per square mile of the watershed of Sudbury River during the same period. The analyses for the third year, June, 1889, to May, 1890, inclusive, were next treated in the same way; and finally the analyses from September, 1887, to December, 1888, were made use of in connection with the average flow of the river, as deduced from actual measurements of the flow during working hours given on page 392. The results obtained in the three cases corresponded quite nearly, showing a high probability that the general results given in the tables are trustworthy.

Returning to the second of these tables, we find that the albuminoid ammonia (which represents the organic nitrogen both in solution and in suspension) amounts at Worcester to 826 pounds daily. At Uxbridge, sixteen miles below, the quantity is reduced to 306 pounds, showing a loss of rather more than half, which may be attributed to the deposit of suspended particles and the decomposition of a portion of the organic matter in solution. From Uxbridge to Millville the quantity increased from 306 to 382

pounds, which may be due to the growth of organisms which appropriate the free ammonia and nitrates, and to the increase from artificial pollution caused by the population and factories on the large area of watershed which drains into the river below Uxbridge. It might be thought that the increase from these causes would be insufficient to offset the decomposition of the organic matter of the Worcester sewage, and this would probably be the case were it not that the portion which still remains in the river is comparatively stable in character.

The free ammonia, which is a product of decomposition and a characteristic component of sewage, decreases, from Worcester to Uxbridge, from 1,728 to 1,629 pounds. It is not probable that this represents the whole loss of free ammonia which takes place in this distance, because a considerable amount must have been developed below Worcester by the decomposition of the dissolved and suspended organic matter, and a further amount, as in the case of other constituents, must have entered with the sewage and other polluting matters turned into the stream at different points below Worcester. This view is supported by the increase of nitrogen as nitrates, from 218 pounds at Worcester to 426 pounds at Uxbridge, which is due to the oxidation of the nitrogen of the free ammonia. From Uxbridge to Millville there is a loss of 330 pounds of free ammonia, and an increase of nitrogen as nitrates of but 31 pounds. In this case the loss of ammonia does not appear to be occasioned to any large extent by oxidation. Some of the nitrogen is undoubtedly appropriated by suspended organisms, and some by fixed plants.

The chlorine shows a gradual increase from point to point, which is easily accounted for by the population below Worcester.

If we estimate the total nitrogen at Worcester and Millville, by methods which in this case are necessarily approximate, we find 3,000 pounds at Worcester and 2,156 pounds at Millville, leaving 844 pounds daily unaccounted for. A portion of this is undoubtedly contained in the suspended matter, which settles to the bottom in mill ponds and sluggish places, and either remains there or is swept down the stream by freshets, thereby generally escaping without being represented in an analysis. It is possible that some of the ammonia may escape into the air, and some may be appropriated by fixed plants. It is also not improbable that a portion of the difference may be due to the unavoidable inaccuracies in comparisons of this kind, as previously indicated.

If from this consideration of details we turn once more to the general results, we find that the water in passing from Worcester to Millville loses rather more than one-half of its organic nitrogen, and that the remaining portion is comparatively stable. There is a loss of one-fourth of the free ammonia, caused partly by the oxidation of its components into nitric acid and water; but the striking fact remains, that, after a flow of twenty-three miles, three-fourths of the free ammonia remains unchanged, notwithstanding the long time required for the water to pass this distance, owing to its slow movement through mill ponds, and the aeration which it receives at the dams.

It is known, as will be shown subsequently, that, in some instances where, by reason of the relatively small amount of sewage discharged into a stream, the amount of ammonia contributed to it is also small, this ammonia disappears rapidly and completely. In the Blackstone River the absolute quantity which disappears is large, but the proportionate quantity is small. It may be that the acid liquors turned into the river from the iron works at Worcester prevent a rapid oxidation of the ammonia, and the great amount to be oxidized may also be an important factor.

The Merrimack River furnishes the best example of high dilution of sewage; for, notwithstanding the great population which discharges sewage into it at Concord, Manchester and Nashua, N. H., and at Lowell, Lawrence and Haverhill, Mass., the water is not at any place very bad, from a chemical stand-point.

By reference to the table on page 446, which contains the average analyses of the river water at several points from above Nashua, N. H., to Haverhill, Mass., it will be observed that most of the constituents increase in quantity, with a fair degree of regularity, from place to place going down the stream.

Two of the constituents, namely, the free ammonia and the albuminoid ammonia in suspension, are exceptions to this rule, in that their increase is not regular, and there is in some instances a noticeable decrease.

The free ammonia at both Lowell and Lawrence is less below the city than above, notwithstanding the large amount of ammonia which is discharged into the river in the sewage of these cities. This feature is shown very prominently by a special examination made in August, 1888, during a moderately low stage of the river, the results of which are given in the following table: —

Special Examination of Merrimack River in August, 1888.

[Parts per 100,000.]

	Date of Collection.	Number of Determinations.	Color.	Residue on Evaporation.			Ammonia.				Chlorine.	Nitrogen as	
								Albuminoid.					
				Total.	Loss on Ignition.	Fixed.	Free.	Total.	Dis-solved.	Sus-pended.		Nitrates.	Nitrites.
	1888.												
Above Nashua, . .	Aug. 15,	1	0.20	3.30	0.80	2.50	.0028	.0128	.0106	.0022	.16	.0050	.0002
Above Lowell, . .	Aug. 16,	3	0.20	3.87	0.80	3.07	.0022	.0159	.0139	.0020	.22	.0073	.0002
Central Bridge, Lowell,	Aug. 17,	1	0.25	3.75	0.90	2.85	.0014	.0178	.0134	.0044	.22	.0090	.0001
Below Lowell, . .	Aug. 16,	3	0.22	4.57	1.08	3.49	.0004	.0181	.0135	.0046	.27	.0073	.0003
Above Lawrence, . .	Aug. 17,	3	0.25	3.85	0.87	2.98	.0043	.0202	.0152	.0050	.24	.0107	.0002
Below Lawrence, . .	Aug. 17,	3	0.28	4.12	0.95	3.17	.0005	.0224	.0159	.0065	.25	.0070	.0002
Above Haverhill, . .	Aug. 17,	2	0.22	4.37	1.07	3.30	.0022	.0216	.0145	.0071	.25	.0160	.0002

The table shows the free ammonia above Lowell to be .0022 parts per 100,000, and that below Lowell .0004. The volume of water flowing in the river at the time was 5,000 cubic feet per second, equal to 70 cubic feet per second for every 1,000 inhabitants in Lowell. By estimates made upon the same basis as the table on page 789, we find enough free ammonia in the sewage to have added to that in the river .0040 parts per 100,000; we have therefore a total of .0062 parts of free ammonia which should be found below Lowell if there was no loss; but in some way all of this has been removed except .0004. The river water after receiving the sewage of the city runs over long rapids known as Hunt's Falls to the sampling place below Lowell.

It might be thought that the loss of free ammonia was caused by the aeration of the water during its passage over these falls; but this cannot be the case because a similar loss occurs at Lawrence where there is no fall in the river below the point where the sewage enters it.*

The amount of free ammonia remaining in the water just below the cities is, as above indicated, very small, but increases to a

* An examination of the water above and below Niagara Falls, made in July, 1890, by Dr. Albert R. Leeds, showed that the aeration of the water during the passage over the falls did not cause any decrease in the free ammonia, — the amount being .0056 parts per 100,000 above and .0059 below. The albuminoid ammonia was .0110 above and .0109 below, the oxygen consumed from potassium permanganate .2260 at both places. — *Journal of the American Chemical Society;* New York, November, 1890.

marked extent as the water flows more sluggishly to points further down stream. This feature is noticeable in the average analyses in the table on page 446, but is more strikingly illustrated by the special examination presented in the table on the preceding page, where the free ammonia is but .0004 below Lowell and increases to .0043 before reaching Lawrence. This increase does not represent free ammonia which was contained as such in the sewage, although it may have its origin in decomposing organic matter discharged into the river in the sewage and manufacturing wastes.

The increase in the amount of albuminoid ammonia from place to place, which is indicated by both of the tables, shows a greater pollution at the lower stations. This fact, however, should not lead us to infer that no purification takes place, because the increase may represent only a part of the organic matter discharged into the stream. Upon this point the information which is necessary to enable any definite conclusions to be drawn is wanting.

Whether the purification of the stream as indicated by the rapid decrease of free ammonia below the cities is any indication of a decrease in the number of disease germs cannot be asserted ; indeed, there does not seem to be, in this case, any necessary connection between the two ; and we do not find that there is any corresponding destruction of the organic matter which the sewage brought into the stream.

A somewhat remarkable example of rapid conversion of the nitrogen compounds found in a polluted water into other forms of nitrogen is furnished at Framingham, where the water of the underdrain of the sewerage system enters and mingles with Beaver Dam Brook, a tributary of Lake Cochituate. The underdrain is laid at a lower level than the sewers, in order to reduce the level of the ground water and to prevent its filtration into the sewers, which would increase the amount of sewage to be pumped and purified by the system of intermittent filtration adopted at this place. That there is no leakage from the sewer into the underdrain is indicated by the fact that its water contains no more free ammonia since sewage has been admitted to the sewer than was found before the sewers were used.

The large amount of chlorine contained in the water of the underdrain shows that it derives a part of its water from cess-pools, which were in general use before the sewerage system was built, and are still used in many instances. Its high contents of free ammonia

also indicate that this water coming from cess-pools is imperfectly purified. The water, however, is colorless and clear, and as it issues from the mouth of the underdrain contains many reddish brown flocks of *Crenothrix*, which rapidly deposit in the more sluggish current of the open channel through which the water flows to Beaver Dam Brook. A series of observations was made Aug. 8, 1890, when the brook was extremely low and the water in it flowed sluggishly through a luxuriant growth of aquatic plants. The flow of the brook after receiving the stream from the underdrain was made up of 45 per cent. of water from the underdrain and 55 per cent. of water from the brook. The following table contains the analyses made at this time: —

Analyses of Water from the Framingham Underdrain and from Beaver Dam Brook above and below it, made Aug. 8, 1890.

[Parts per 100,000.]

Sample Collected from	Chlorine.	Ammonia.			Nitrogen as		Total Nitrogen.
		Free.	Albuminoid.		Nitrates.	Nitrites.	
			Dis-solved.	Sus-pended.			
Beaver Dam Brook, above entrance of stream from underdrain,	0.77	.0018	.0146	.0022	.0125	.0001	.0427
Underdrain at outlet,	3.62	.0648	.0058	.0000	.6000	.0036	.6665
Brook, 300 feet below entrance of stream from underdrain,	2.20	.0236	.0100	.0002	.2200	.0023	.2586
Mouth of brook proper, 1 mile below underdrain,	2.02	.0016	.0134	.0018	.2000	.0005	.2276
Estuary of brook, 1,700 feet below its mouth,	1.54	.0024	.0302	.0450	.0200	.0019	.1664
Estuary of brook, 2,100 feet below its mouth,	1.39	.0044	.0286	.0240	.0200	.0012	.1214

The analysis of the sample collected from the brook 300 feet below the entrance of the stream from the underdrain shows very nearly the result which might be expected from mixing the waters if no chemical changes occurred. At points further down stream there is a gradual reduction in the amount of chlorine, owing to dilution; but there are vastly greater changes in the nitrogen compounds. At the mouth of the brook, one mile from the underdrain, very nearly all the free ammonia added by it has disappeared, with a slight increase in albuminoid ammonia over the amount due to the admixture of the waters. The nitrates do not show any marked change until the estuary of the brook is reached, when they are reduced

from .2000 to .0200 parts per 100,000. This reduction was caused by an enormous growth of *Anabæna*, *Synedra* and *Zoospores*, together with many other organisms in smaller numbers. These changes made the water in the estuary turbid and green, and consequently unfit for drinking, on account of its bad taste, odor and appearance.

It will be seen from the foregoing, that, in flowing from the outlet of the underdrain to the lake, the nitrogen compounds are radically transformed by organic growths; and it seems reasonable to conclude that this means the destruction of substances undergoing decomposition which were contained in the water of the underdrain. We may, therefore, from a health stand-point, class this as an instance of self-purification of streams, even though the water is temporarily rendered obnoxious by the organisms which have effected the change.

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